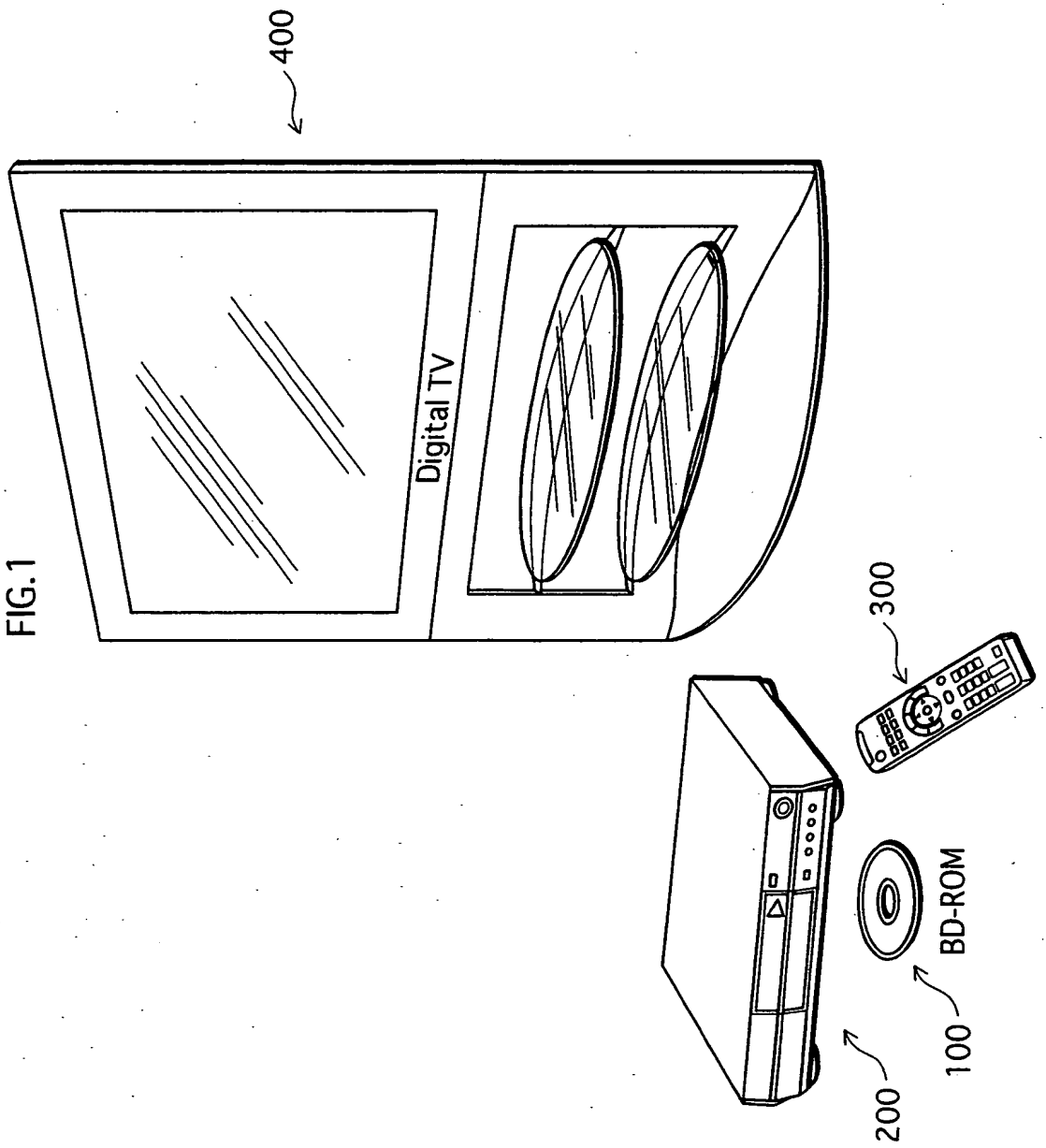


FIG.1

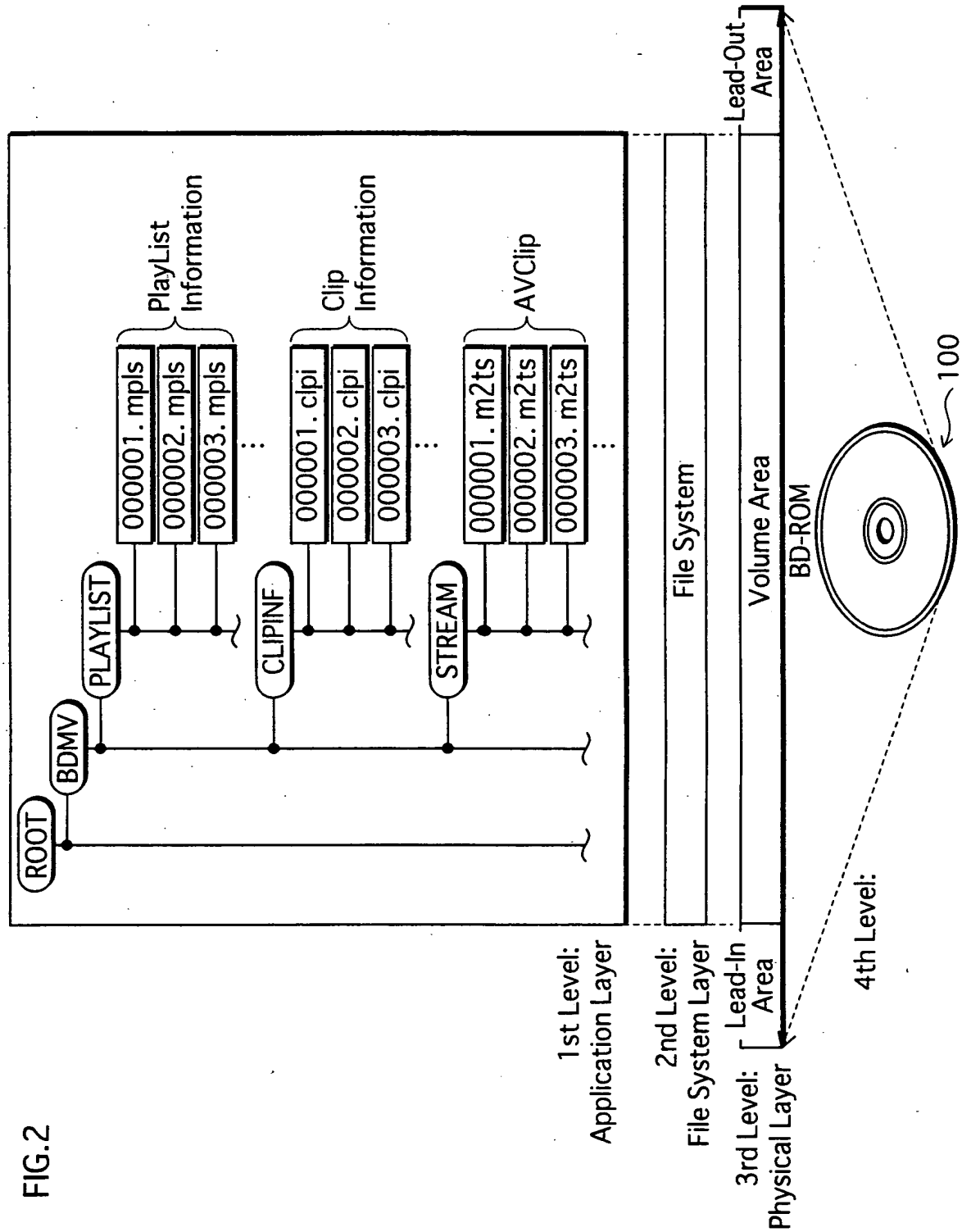

ROOT
BDMV
PLAYLIST
CLIPINF
STREAM
000001.mpls
000002.mpls
000003.mpls
PlayList Information
000001.clpi
000002.clpi
000003.clpi
Clip Information
000001.m2ts
000002.m2ts
000003.m2ts
AVClip
1st Level: Application Layer
2nd Level: File System Layer
3rd Level: Physical Layer
4th Level:
File System
Lead-In Area
Volume Area
Lead-Out Area
BD-ROM
100

FIG.2

FIG.3

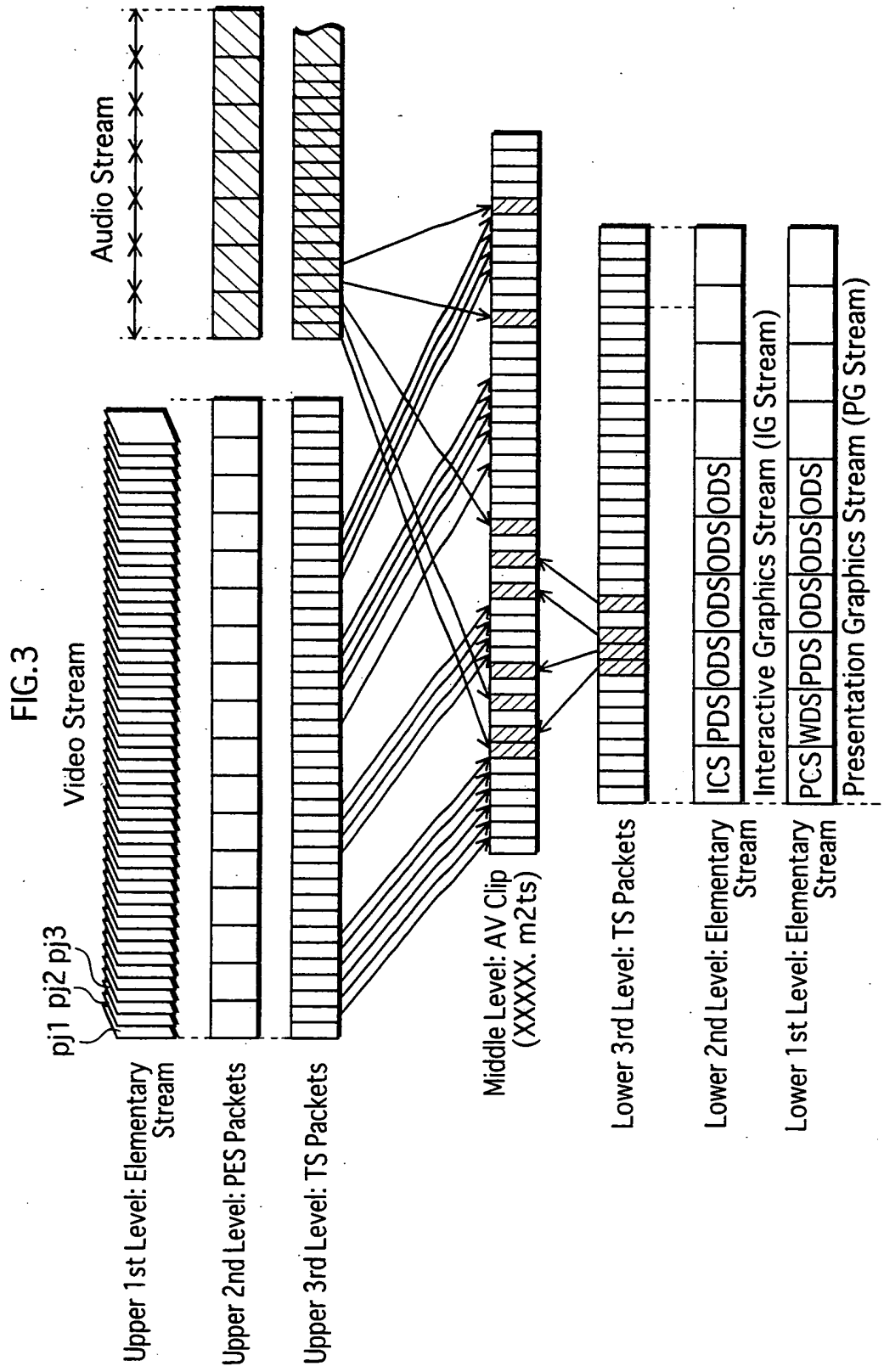
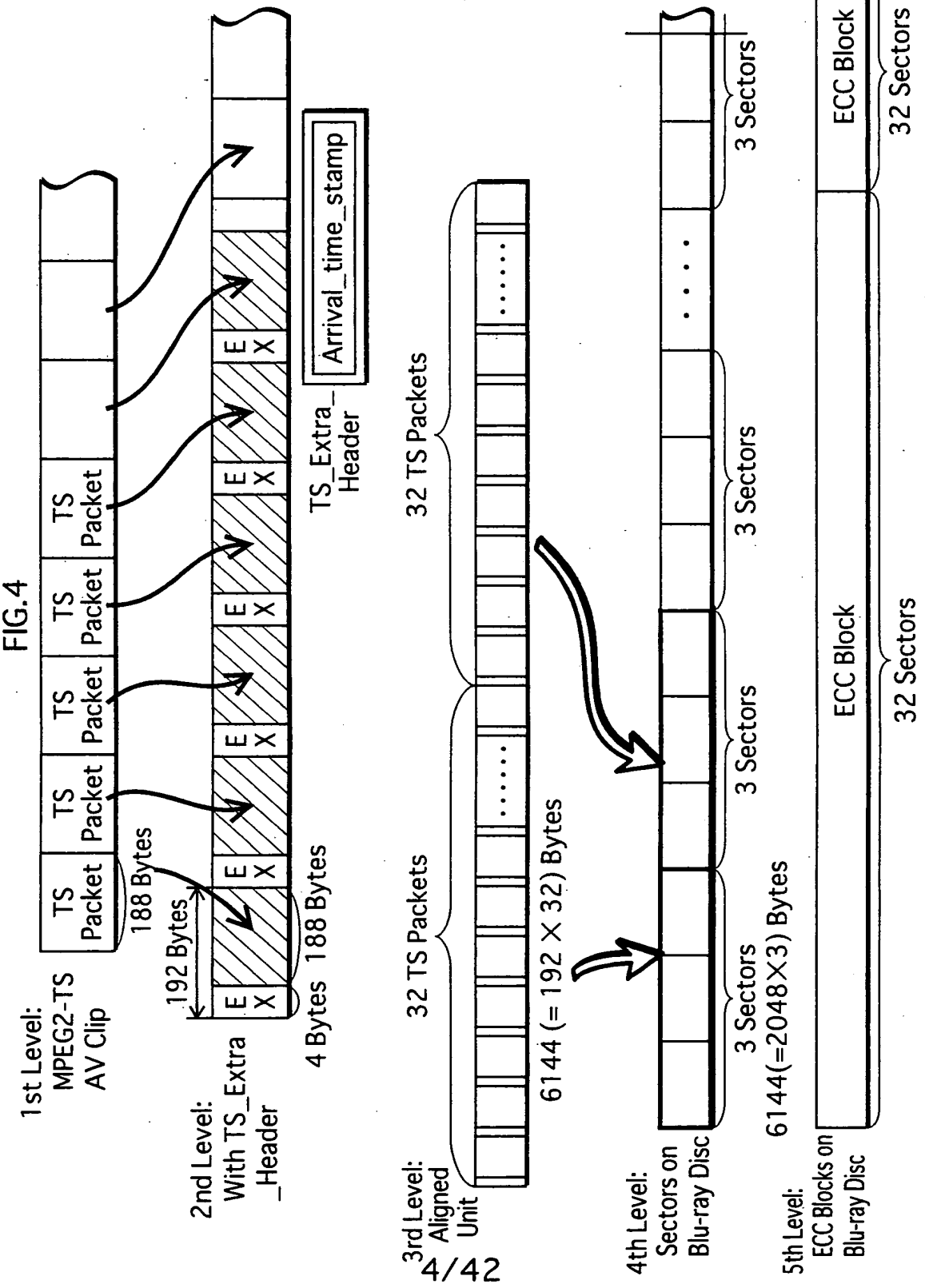

Audio Stream
Video Stream
pj1 pj2 pj3
Upper 1st Level: Elementary Stream
Upper 2nd Level: PES Packets
Upper 3rd Level: TS Packets
Middle Level: AV Clip (XXXXX. m2ts)
Lower 3rd Level: TS Packets
Lower 2nd Level: Elementary Stream
ICS PDS ODS ODS ODS ODS
Interactive Graphics Stream (IG Stream)
Lower 1st Level: Elementary Stream
PCS WDS PDS ODS ODS ODS
Presentation Graphics Stream (PG Stream)

FIG.4


1st Level:
MPEG2-TS
AV Clip
TS Packet
188 Bytes
192 Bytes
EX
2nd Level:
With TS_Extra
_Header
4 Bytes
188 Bytes
TS_Extra_
Header
Arrival_time_stamp
32 TS Packets
3rd Level:
Aligned
Unit
6144 (= 192 × 32) Bytes
4th Level:
Sectors on
Blu-ray Disc
3 Sectors
5th Level:
ECC Blocks on
Blu-ray Disc
6144(=2048×3) Bytes
ECC Block
32 Sectors

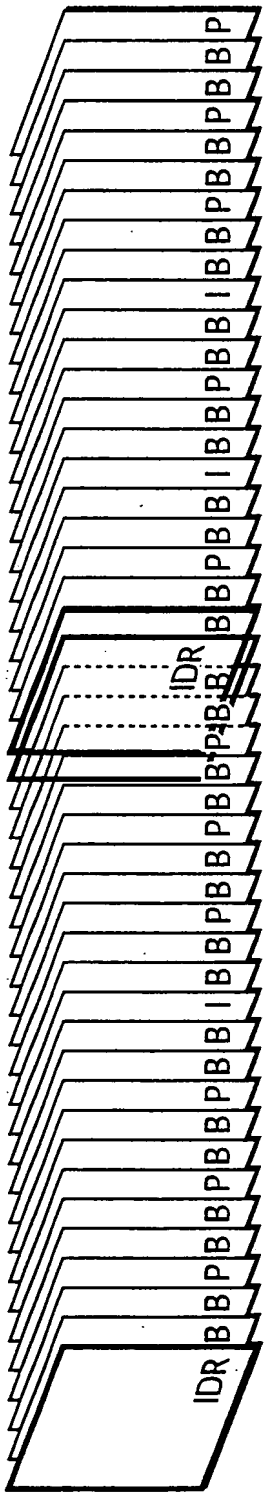


FIG.5A
MPEG4-AVC
Video Stream
(Coding Order)

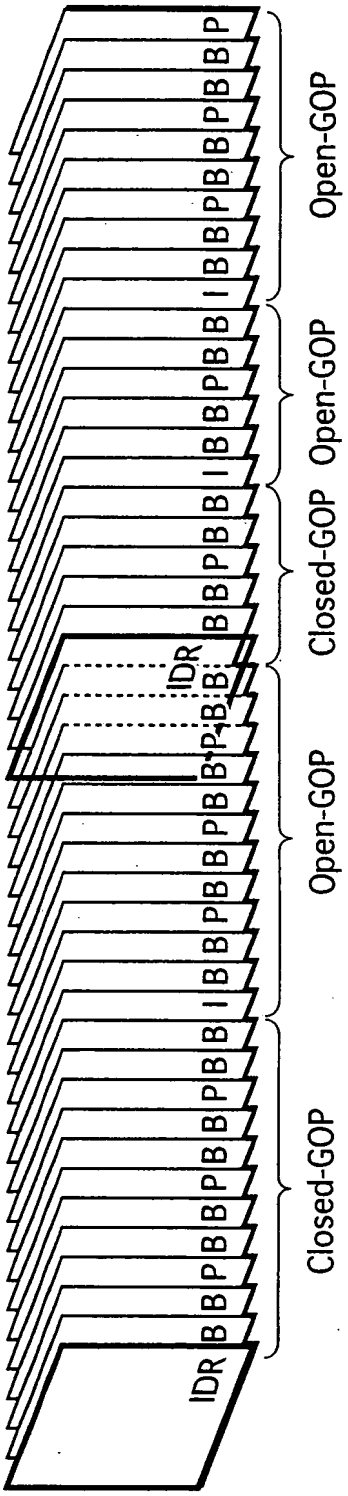


FIG.5B

FIG.6A

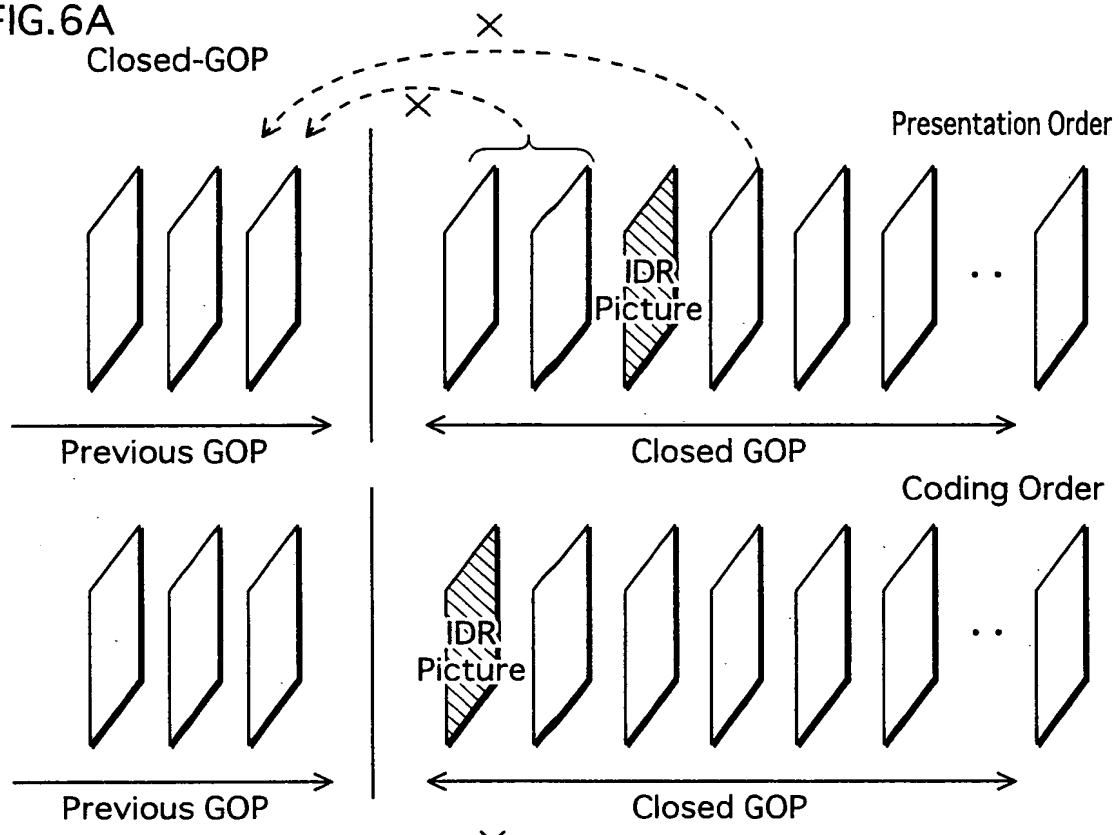

Closed-GOP
Presentation Order
IDR Picture
Previous GOP
Closed GOP
Coding Order
IDR Picture
Previous GOP
Closed GOP

FIG.6B

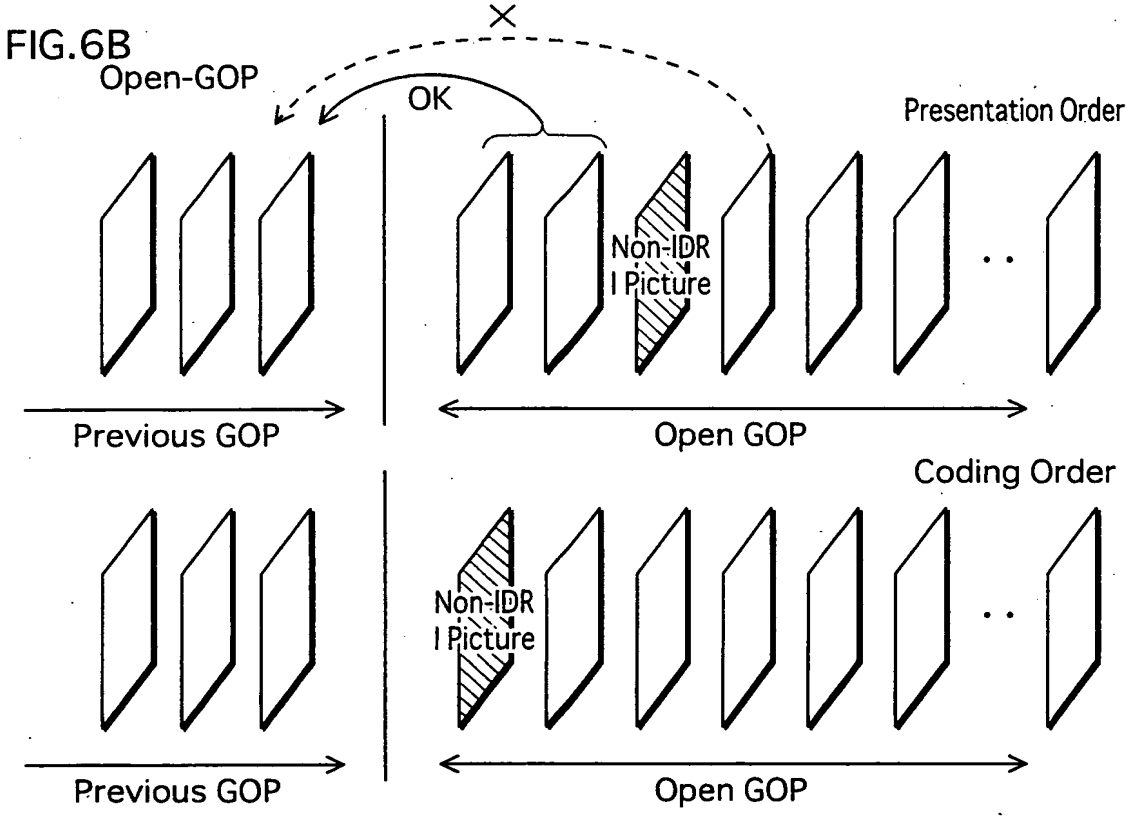

Open-GOP
OK
Presentation Order
Non-IDR I Picture
Previous GOP
Open GOP
Coding Order
Non-IDR I Picture
Previous GOP
Open GOP

FIG.7A

IDR Picture in
MPEG4-AVC Format

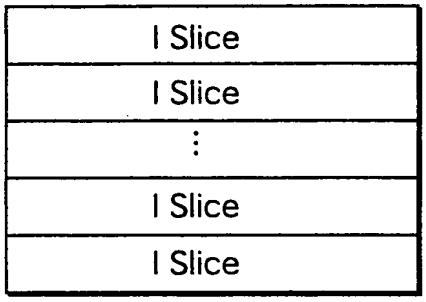


FIG.7B

Non-IDR I Picture

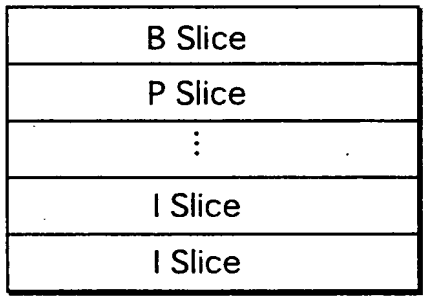
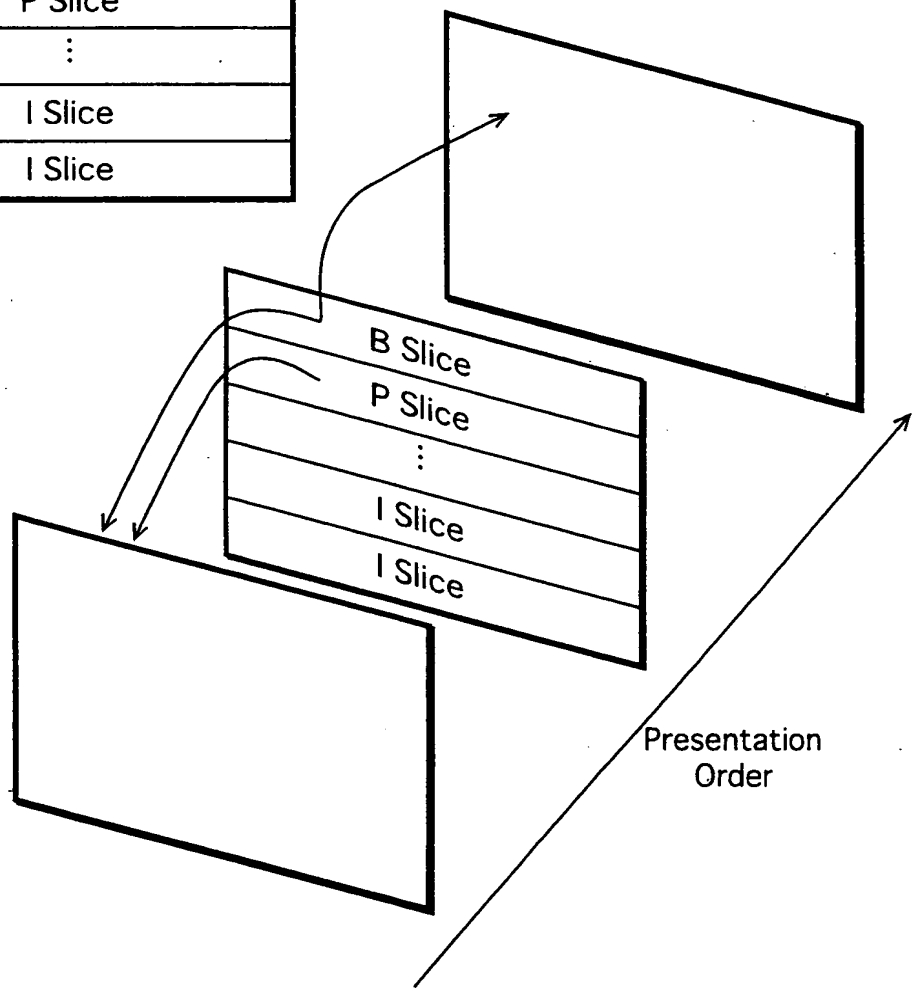


FIG.7C



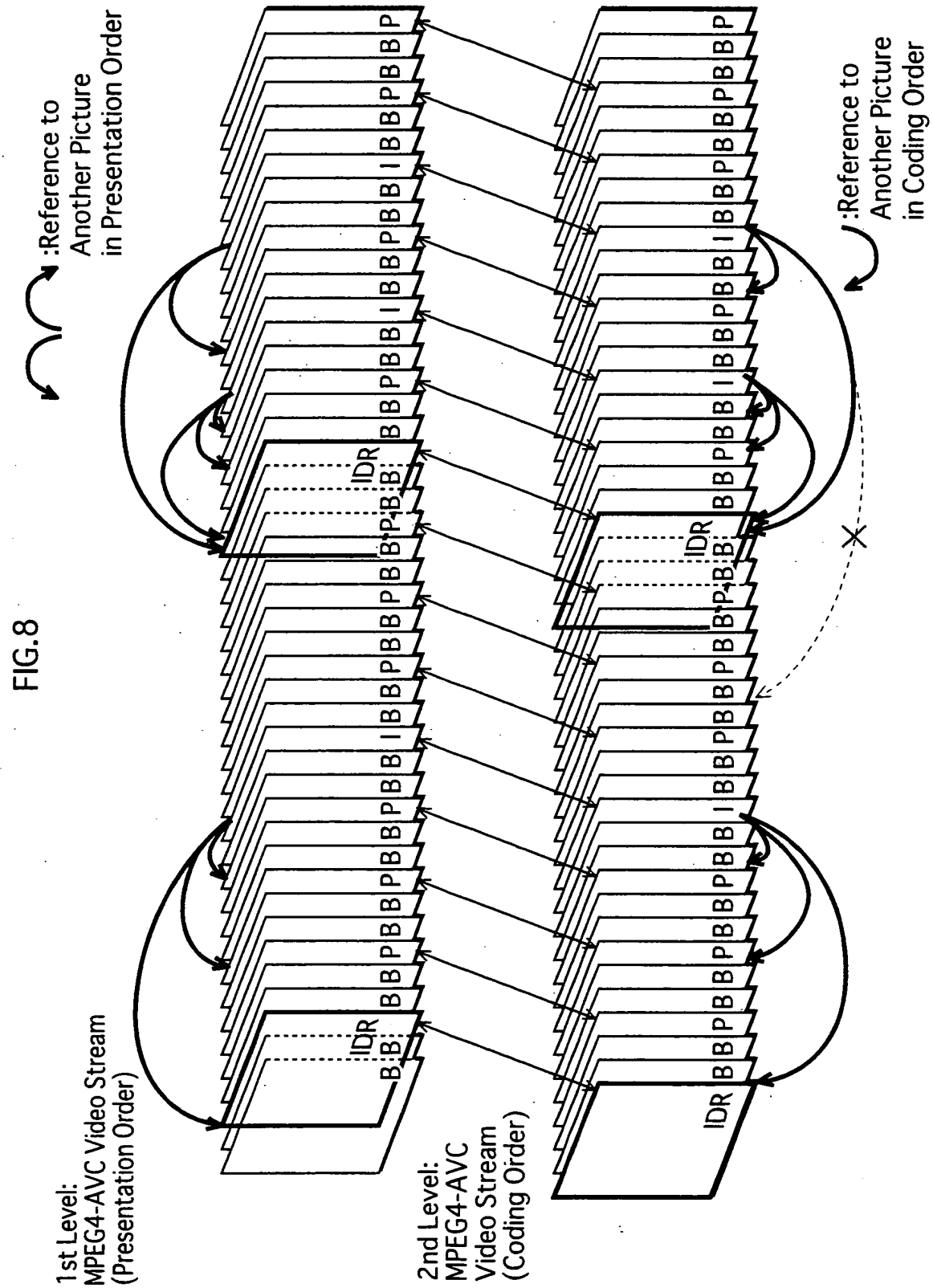

:Reference to Another Picture in Presentation Order
:Reference to Another Picture in Coding Order
1st Level: MPEG4-AVC Video Stream (Presentation Order)
2nd Level: MPEG4-AVC Video Stream (Coding Order)
IDR
B
P
I

FIG.8

FIG.9

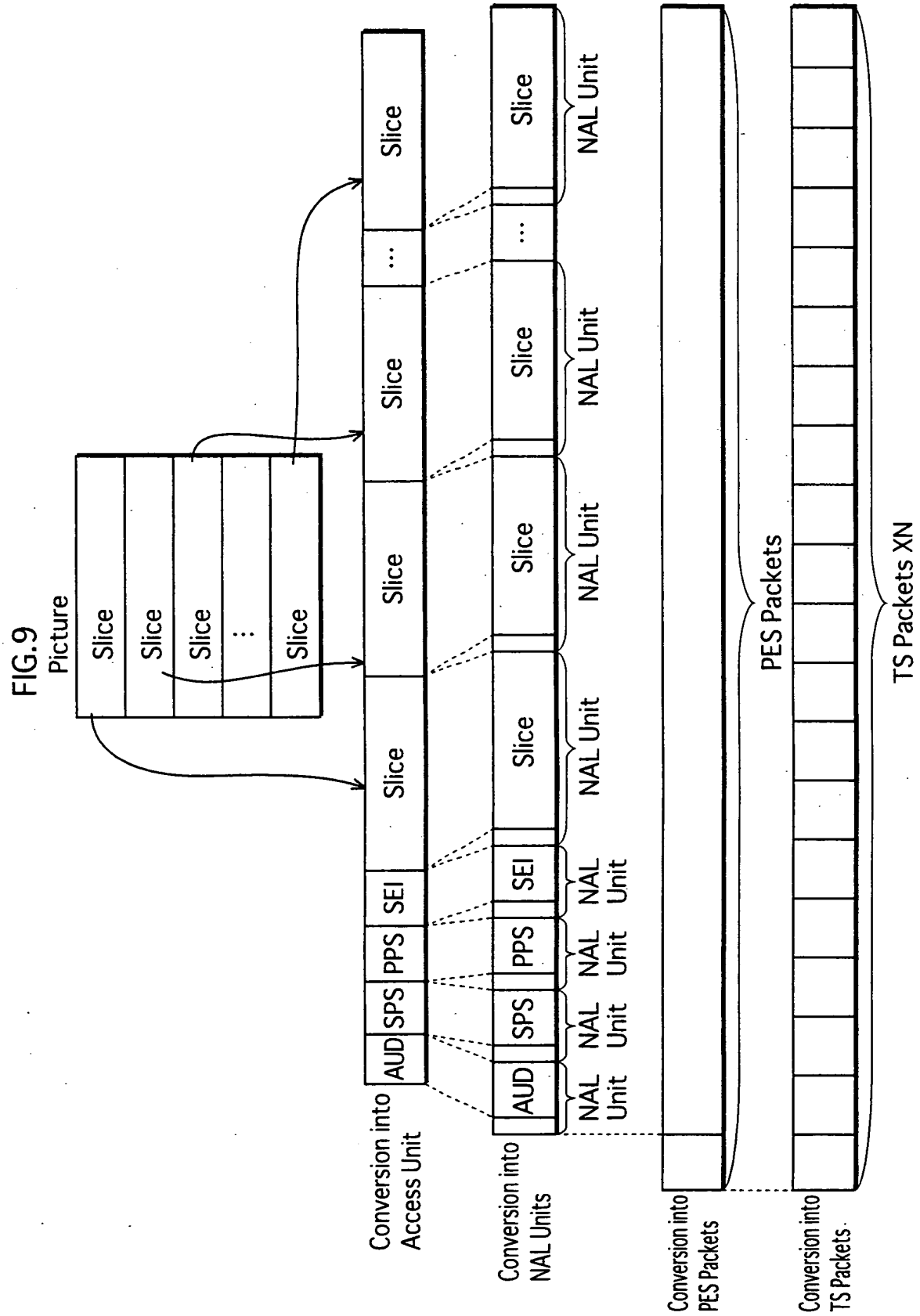

Picture
Slice
Slice
Slice
...
Slice
Conversion into Access Unit
AUD
SPS
PPS
SEI
Slice
...
Slice
Conversion into NAL Units
NAL Unit
Conversion into PES Packets
PES Packets
Conversion into TS Packets
TS Packets XN

FIG.10

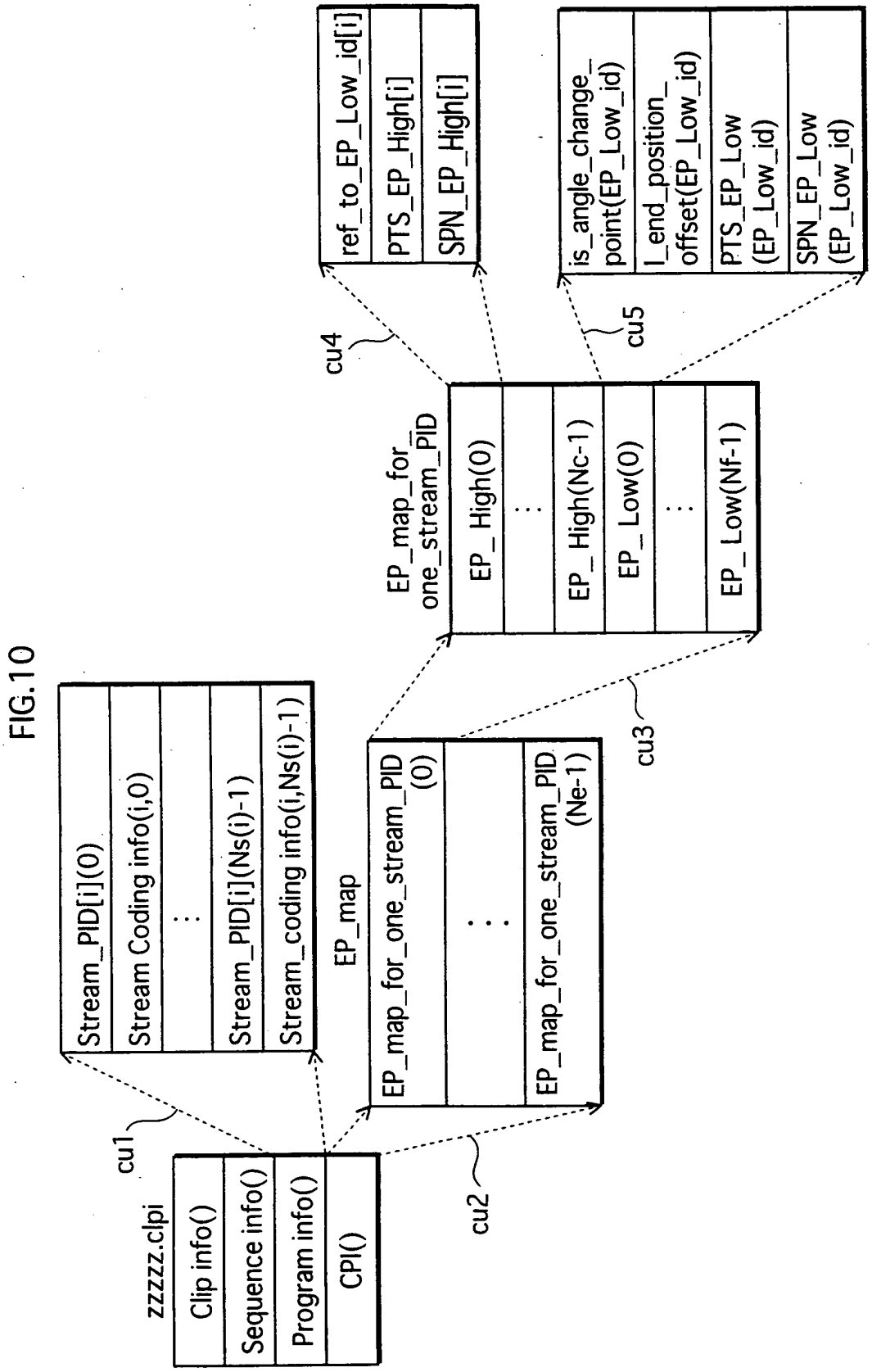

zzzzz.clpi
Clip info()
Sequence info()
Program info()
CPI()
cu1
cu2
Stream_PID[i](0)
Stream Coding info(i,0)
Stream_PID[i](Ns(i)-1)
Stream_coding info(i,Ns(i)-1)
EP_map
EP_map_for_one_stream_PID (0)
EP_map_for_one_stream_PID (Ne-1)
cu3
EP_map_for_one_stream_PID
EP_ High(0)
EP_ High(Nc-1)
EP_ Low(0)
EP_ Low(Nf-1)
cu4
ref_to_EP_Low_id[i]
PTS_EP_High[i]
SPN_EP_High[i]
cu5
is_angle_change_point(EP_Low_id)
I_end_position_offset(EP_Low_id)
PTS_EP_Low (EP_Low_id)
SPN_EP_Low (EP_Low_id)

FIG.11A

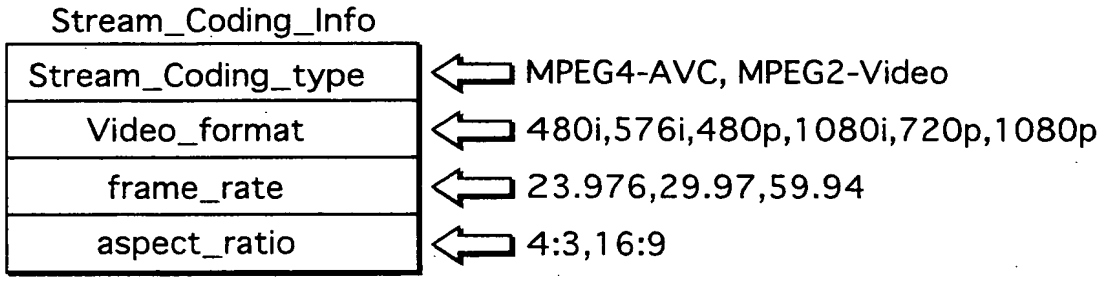


FIG.11B

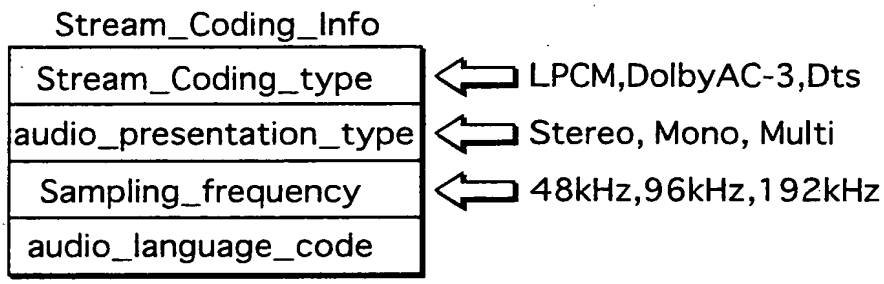


FIG.12

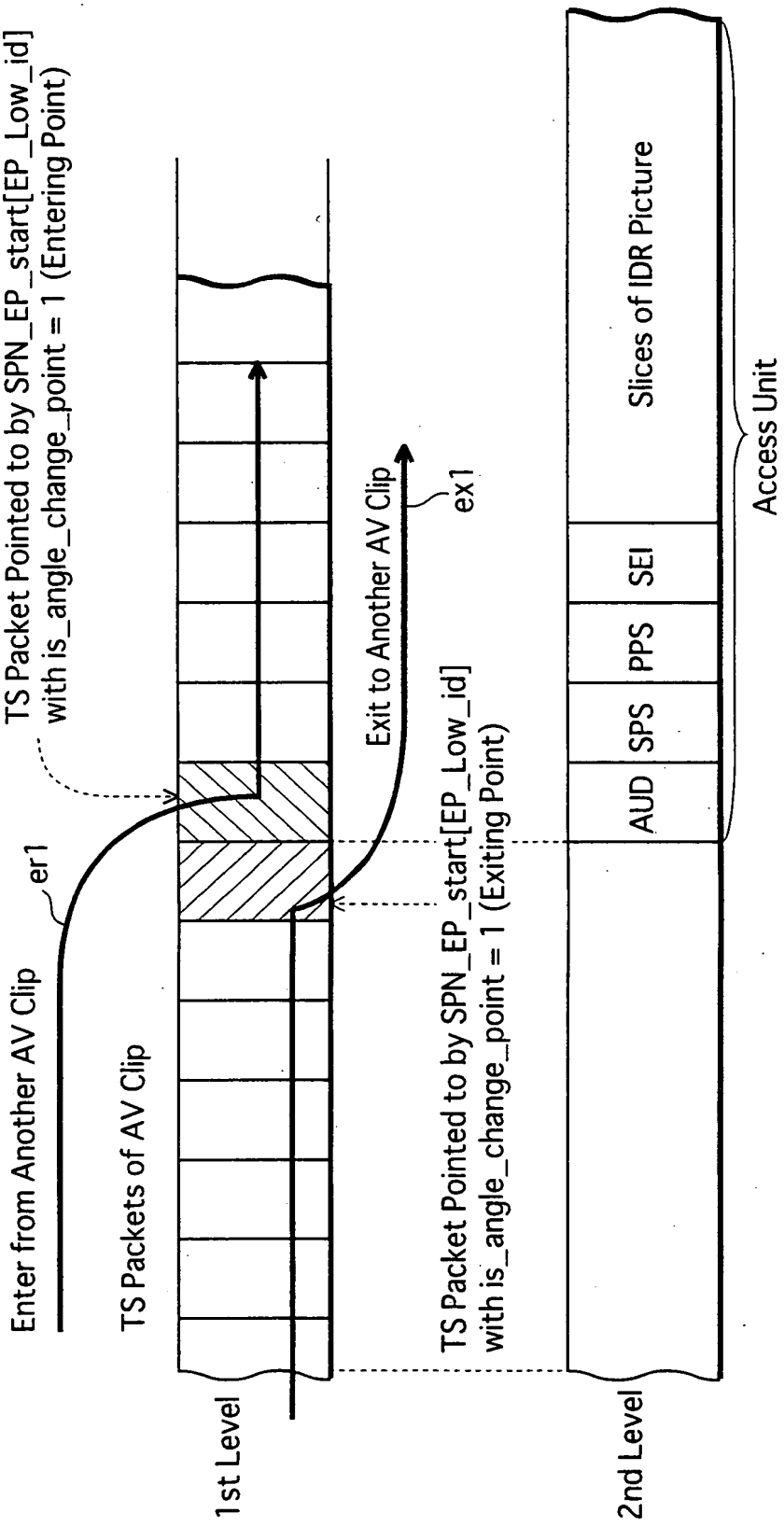

TS Packet Pointed to by SPN_EP_start[EP_Low_id]
with is_angle_change_point = 1 (Entering Point)
Enter from Another AV Clip
er1
TS Packets of AV Clip
Exit to Another AV Clip
ex1
TS Packet Pointed to by SPN_EP_start[EP_Low_id]
with is_angle_change_point = 1 (Exiting Point)
1st Level
2nd Level
AUD
SPS
PPS
SEI
Slices of IDR Picture
Access Unit

FIG.13

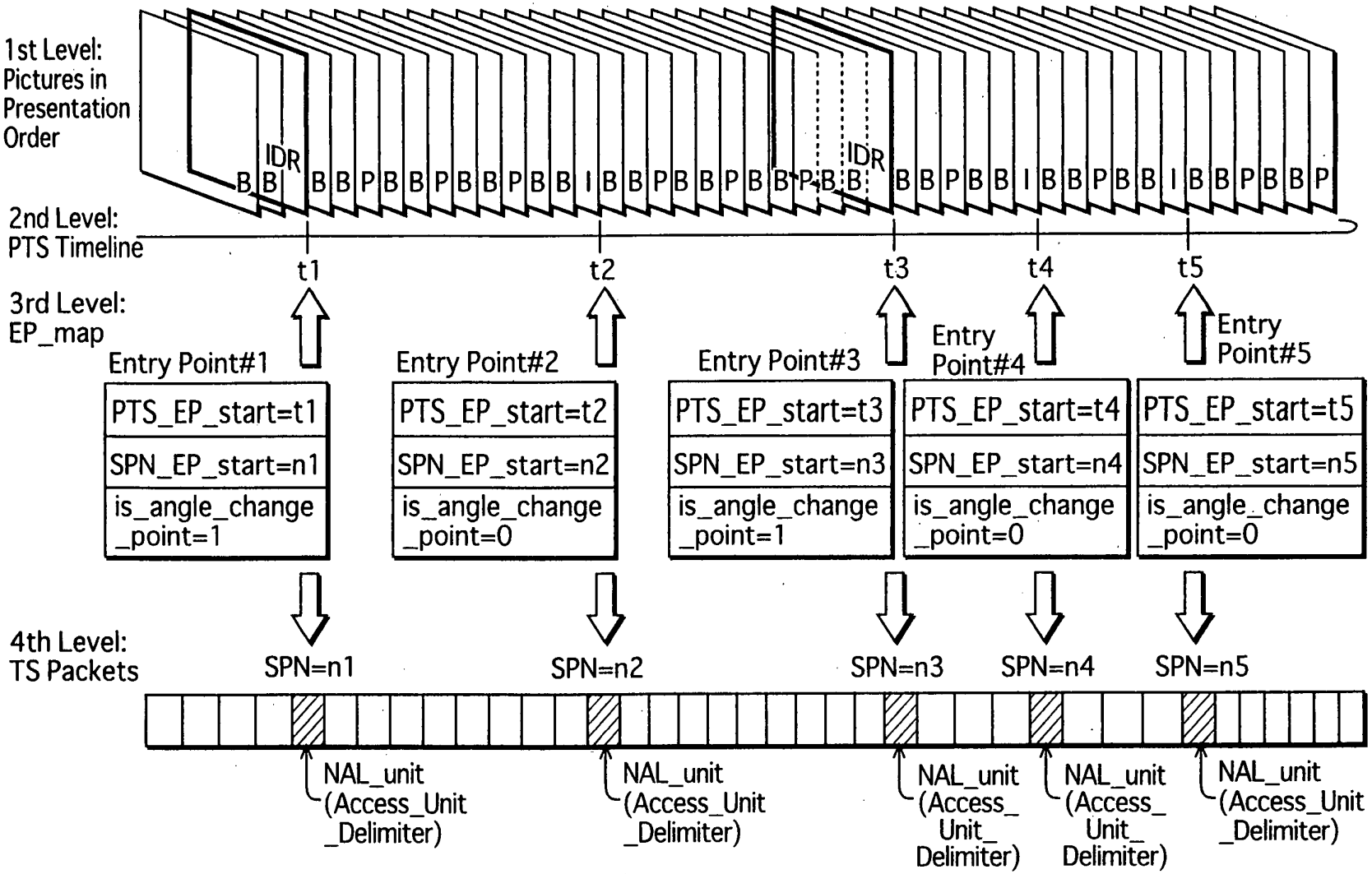


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FIG.14

EP_Low(0)~(Nf-1)

⋮	⋮	⋮
is_angle_change_point (i)=1	LSBs of PTS_EP_Low(i) = t1	LSBs of SPN_EP_Low(i) = n1
is_angle_change_point (i+1)=0	LSBs of PTS_EP_Low(i+1) = t2	LSBs of SPN_EP_Low(i+1) = n2
is_angle_change_point (i+2)=1	LSBs of PTS_EP_Low(i+2) = t3	LSBs of SPN_EP_Low(i+2) = n3
is_angle_change_point (i+3)=0	LSBs of PTS_EP_Low(i+3) = t4	LSBs of SPN_EP_Low(i+3) = n4
is_angle_change_point (i+4)=0	LSBs of PTS_EP_Low(i+4) = t5	LSBs of SPN_EP_Low(i+4) = n5
⋮	⋮	⋮
is_angle_change_point (j)=0	PTS_EP_Low (j)	SPN_EP_Low (j)
is_angle_change_point (j+1)=0	PTS_EP_Low (j+1)	SPN_EP_Low (j+1)
is_angle_change_point (j+2)=0	PTS_EP_Low (j+2)	SPN_EP_Low (j+2)
⋮	⋮	⋮
is_angle_change_point (k)=0	PTS_EP_Low (k)	SPN_EP_Low (k)
is_angle_change_point (k+1)=0	PTS_EP_Low (k+1)	SPN_EP_Low (k+1)
is_angle_change_point (k+2)=0	PTS_EP_Low (k+2)	SPN_EP_Low (k+2)
⋮	⋮	⋮

EP_High(0)~(Nc-1)

⋮	⋮	⋮
Values of ref_to_EP_Low_id(A) = EP_Low(i)	Common MSBs of PTS_EP_High(A) = t1-t5	Common MSBs of SPN_EP_High(A) = n1-n5
ref_to_EP_Low_id (A+1)	PTS_EP_High(A+1)	SPN_EP_High_(A+1)
ref_to_EP_Low_id (A+2)	PTS_EP_High(A+2)	SPN_EP_High_(A+2)
⋮	⋮	⋮

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FIG.15

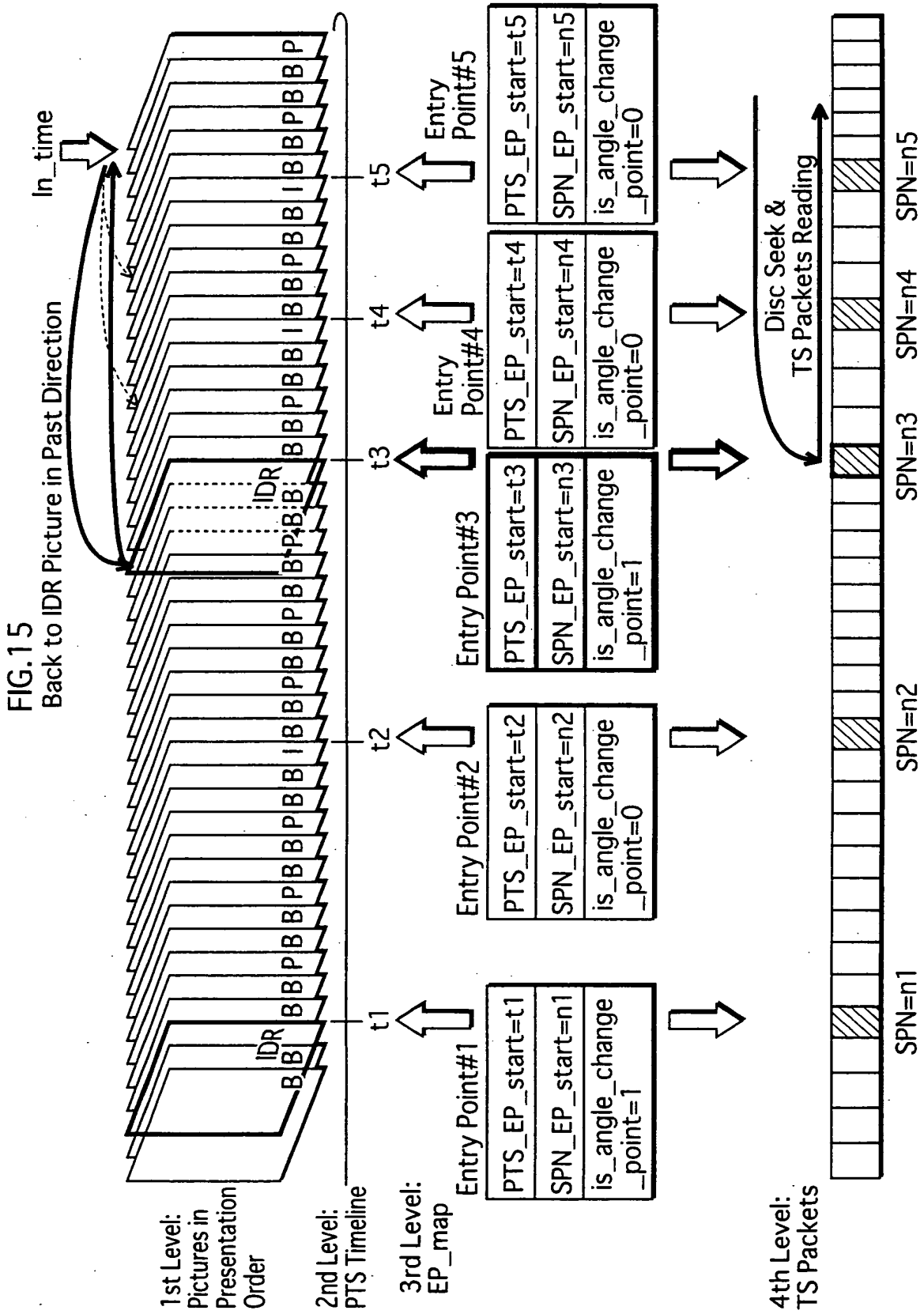
In_time
Back to IDR Picture in Past Direction
1st Level: Pictures in Presentation Order
2nd Level: PTS Timeline
3rd Level: EP_map
4th Level: TS Packets
t1
t2
t3
t4
t5
Entry Point#1
Entry Point#2
Entry Point#3
Entry Point#4
Entry Point#5
PTS_EP_start=t1
SPN_EP_start=n1
is_angle_change _point=1
PTS_EP_start=t2
SPN_EP_start=n2
is_angle_change _point=0
PTS_EP_start=t3
SPN_EP_start=n3
is_angle_change _point=1
PTS_EP_start=t4
SPN_EP_start=n4
is_angle_change _point=0
PTS_EP_start=t5
SPN_EP_start=n5
is_angle_change _point=0
Disc Seek & TS Packets Reading
SPN=n1
SPN=n2
SPN=n3
SPN=n4
SPN=n5

FIG.16

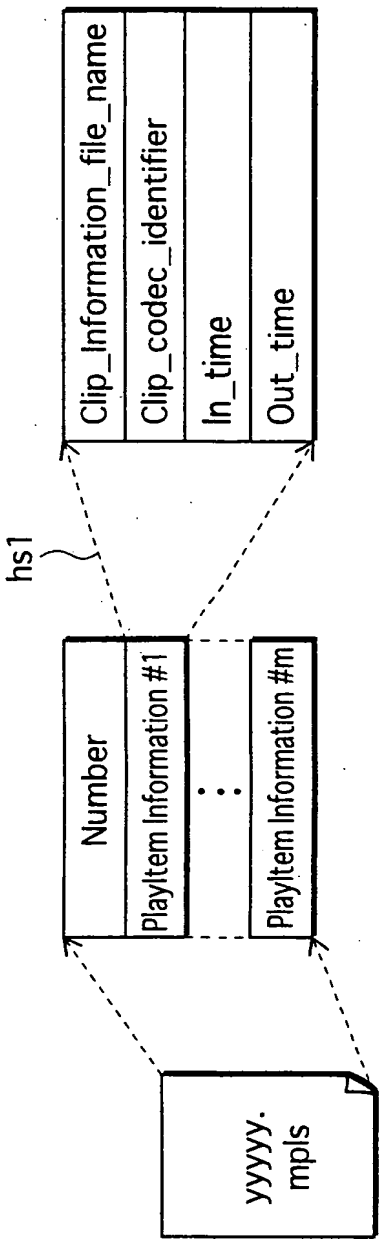
hs1
Clip_Information_file_name
Clip_codec_identifier
In_time
Out_time
Number
PlayItem Information #1
PlayItem Information #m
yyyyy.
mpls

FIG.17

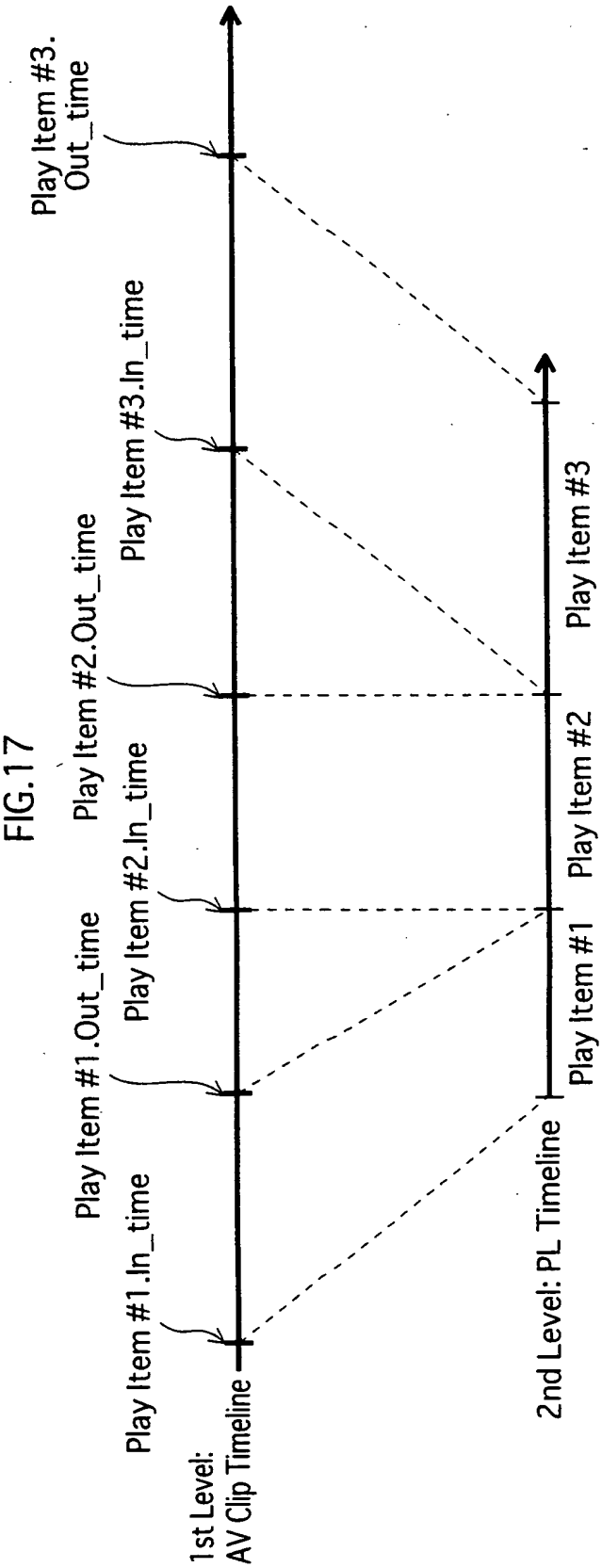
Play Item #3.
Out_time
Play Item #3.In_time
Play Item #2.Out_time
Play Item #2.In_time
Play Item #1.Out_time
Play Item #1.In_time
1st Level:
AV Clip Timeline
Play Item #1
Play Item #2
Play Item #3
2nd Level: PL Timeline

FIG.18

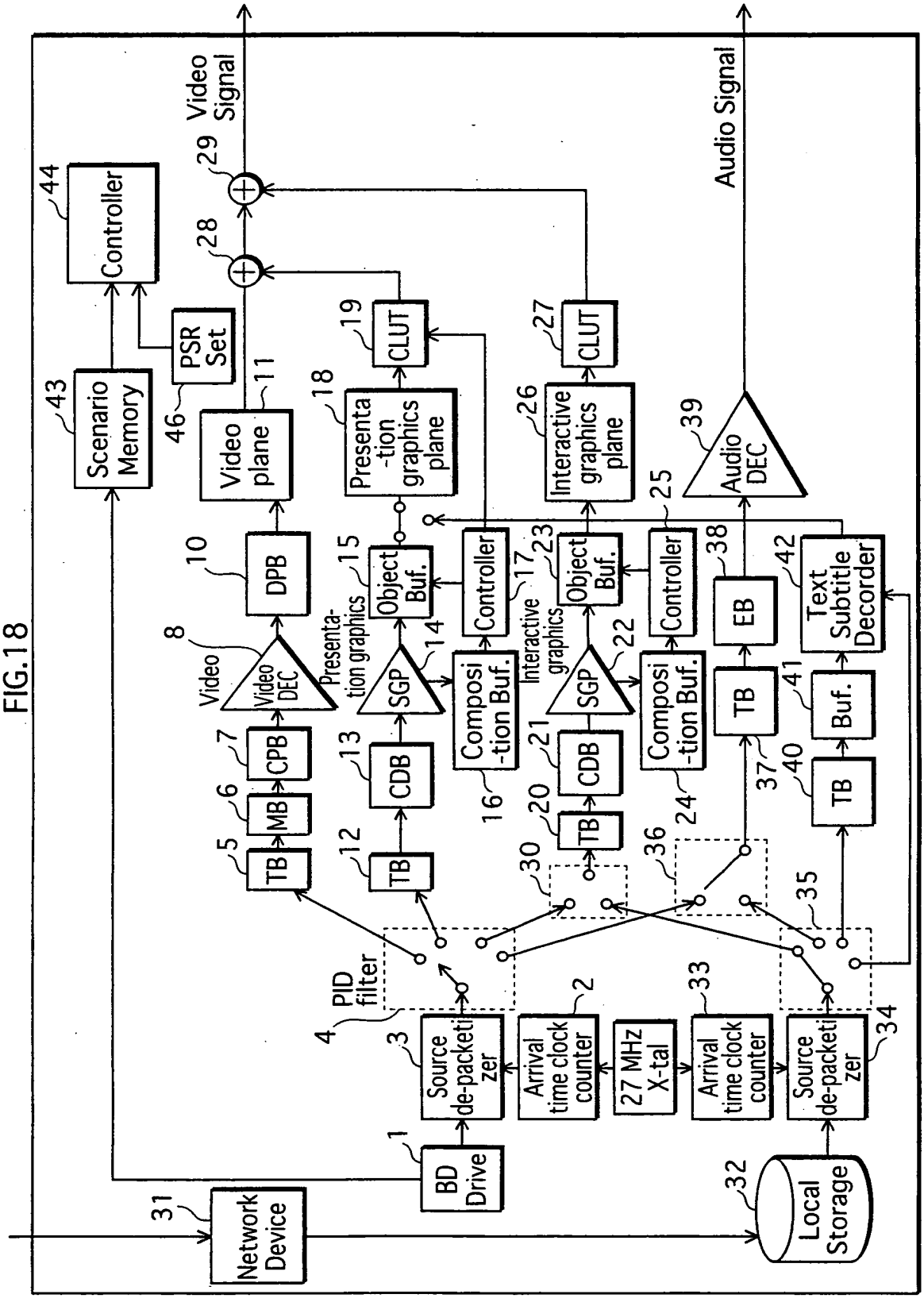
Video Signal
Audio Signal
Controller
PSR Set
Scenario Memory
Video plane
Presenta-tion graphics plane
Interactive graphics plane
CLUT
CLUT
Audio DEC
DPB
Video DEC
Video
Object Buf.
Controller
Presenta-tion graphics
SGP
Composi-tion Buf.
Object Buf.
Controller
Interactive graphics
SGP
Composi-tion Buf.
EB
Text Subtitle Decorder
TB
MB
CPB
TB
CDB
TB
CDB
TB
TB
Buf.
TB
PID filter
Source de-packeti zer
Arrival time clock counter
27 MHz X-tal
Arrival time clock counter
Source de-packeti zer
BD Drive
Network Device
Local Storage

FIG. 19

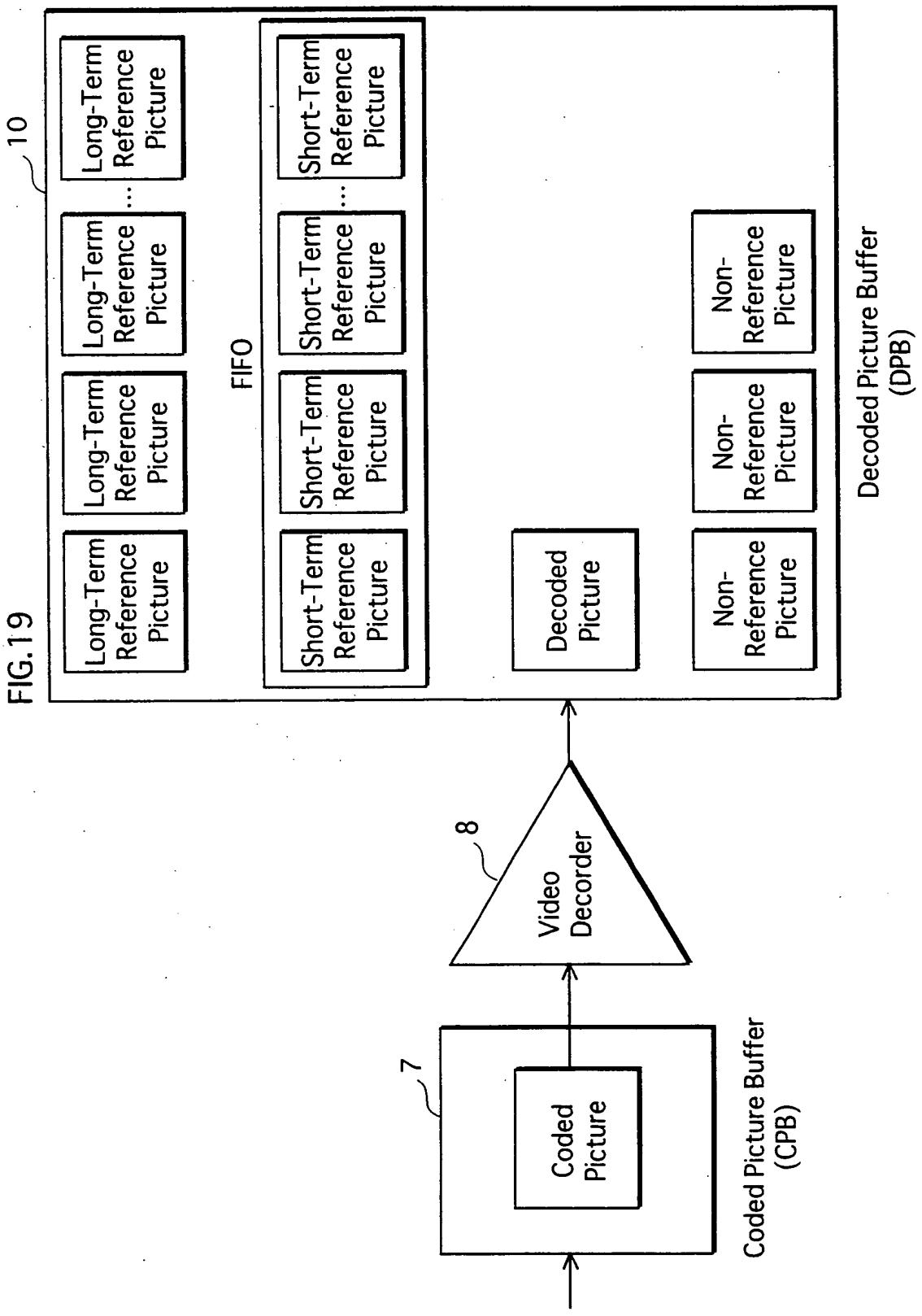
10
Long-Term Reference Picture
Long-Term Reference Picture
Long-Term Reference Picture
Short-Term Reference Picture
Short-Term Reference Picture
Short-Term Reference Picture
FIFO
Decoded Picture
Non-Reference Picture
Non-Reference Picture
Non-Reference Picture
Decoded Picture Buffer (DPB)
8
Video Decorder
7
Coded Picture
Coded Picture Buffer (CPB)

FIG.20

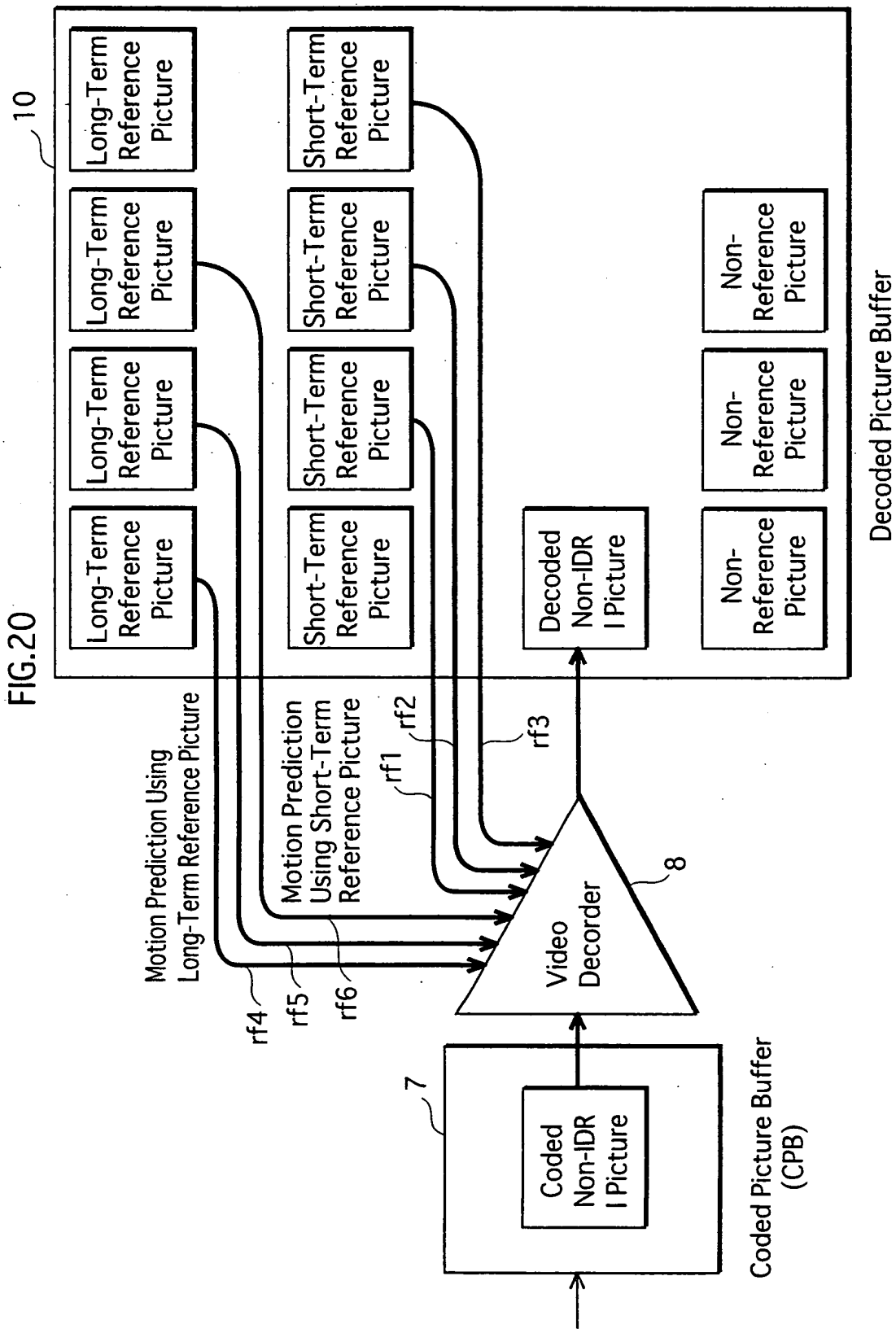
10
Long-Term Reference Picture
Short-Term Reference Picture
Non-Reference Picture
Decoded Picture Buffer (DPB)
Decoded Non-IDR I Picture
Motion Prediction Using Long-Term Reference Picture
Motion Prediction Using Short-Term Reference Picture
rf1
rf2
rf3
rf4
rf5
rf6
Video Decorder
8
7
Coded Non-IDR I Picture
Coded Picture Buffer (CPB)

FIG.21

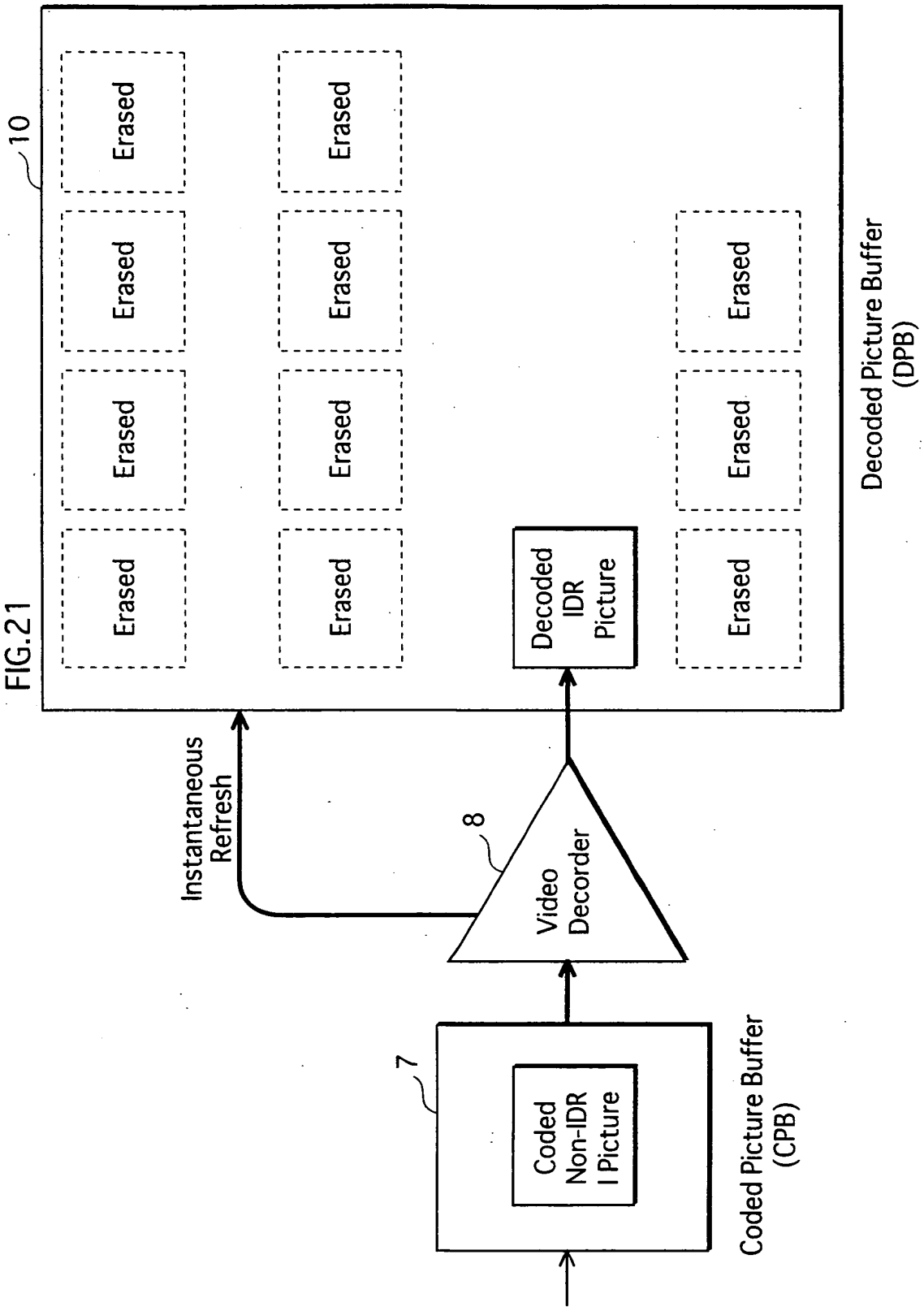
10
Erased
Erased
Erased
Erased
Erased
Erased
Erased
Erased
Erased
Erased
Erased
Erased
Decoded IDR Picture
Decoded Picture Buffer (DPB)
Instantaneous Refresh
8
Video Decorder
7
Coded Non-IDR I Picture
Coded Picture Buffer (CPB)

FIG.22

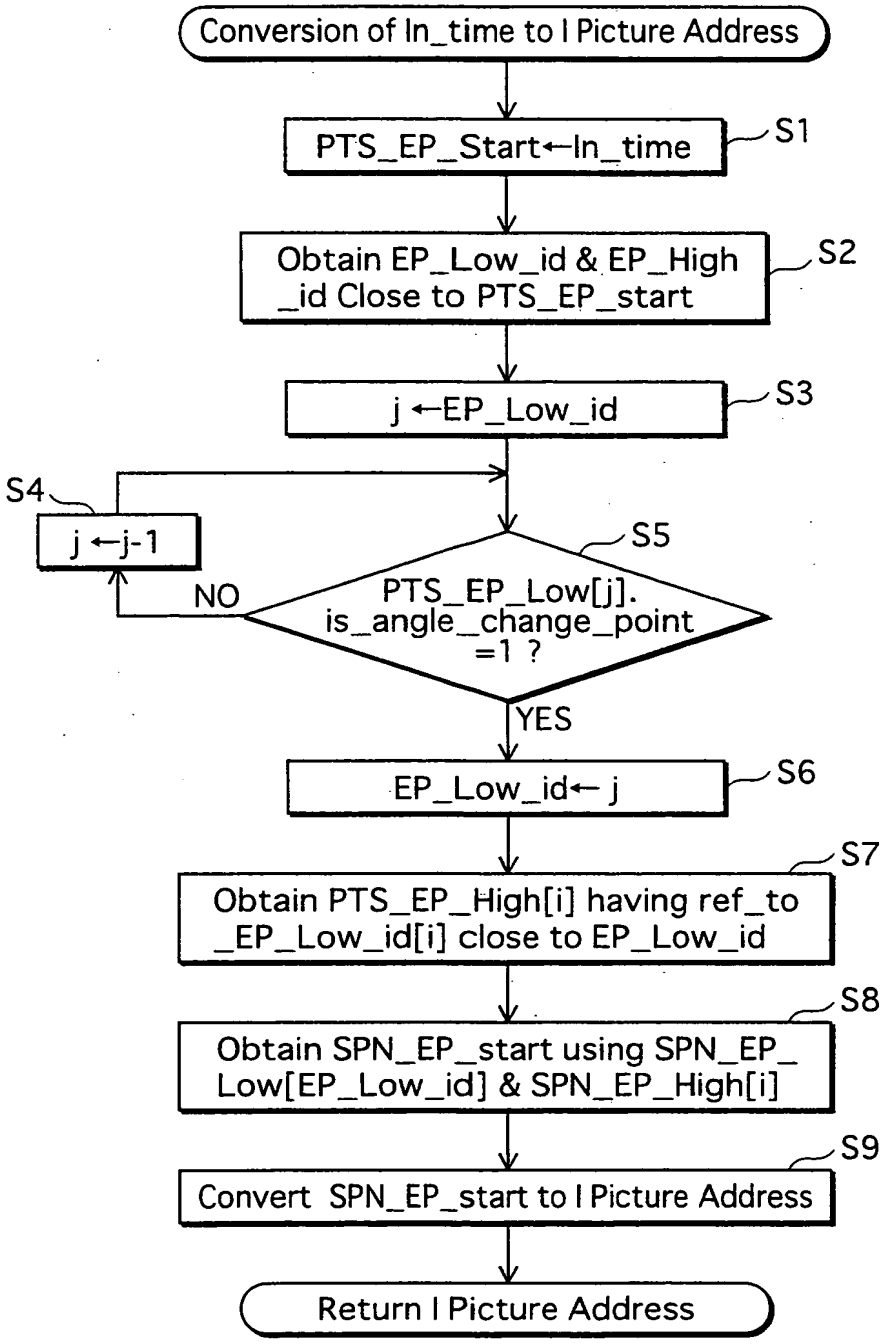
Conversion of In_time to I Picture Address
PTS_EP_Start←In_time
S1
Obtain EP_Low_id & EP_High _id Close to PTS_EP_start
S2
j ←EP_Low_id
S3
S4
j ←j-1
S5
PTS_EP_Low[j]. is_angle_change_point =1 ?
NO
YES
EP_Low_id← j
S6
Obtain PTS_EP_High[i] having ref_to _EP_Low_id[i] close to EP_Low_id
S7
Obtain SPN_EP_start using SPN_EP_ Low[EP_Low_id] & SPN_EP_High[i]
S8
Convert SPN_EP_start to I Picture Address
S9
Return I Picture Address

FIG.23

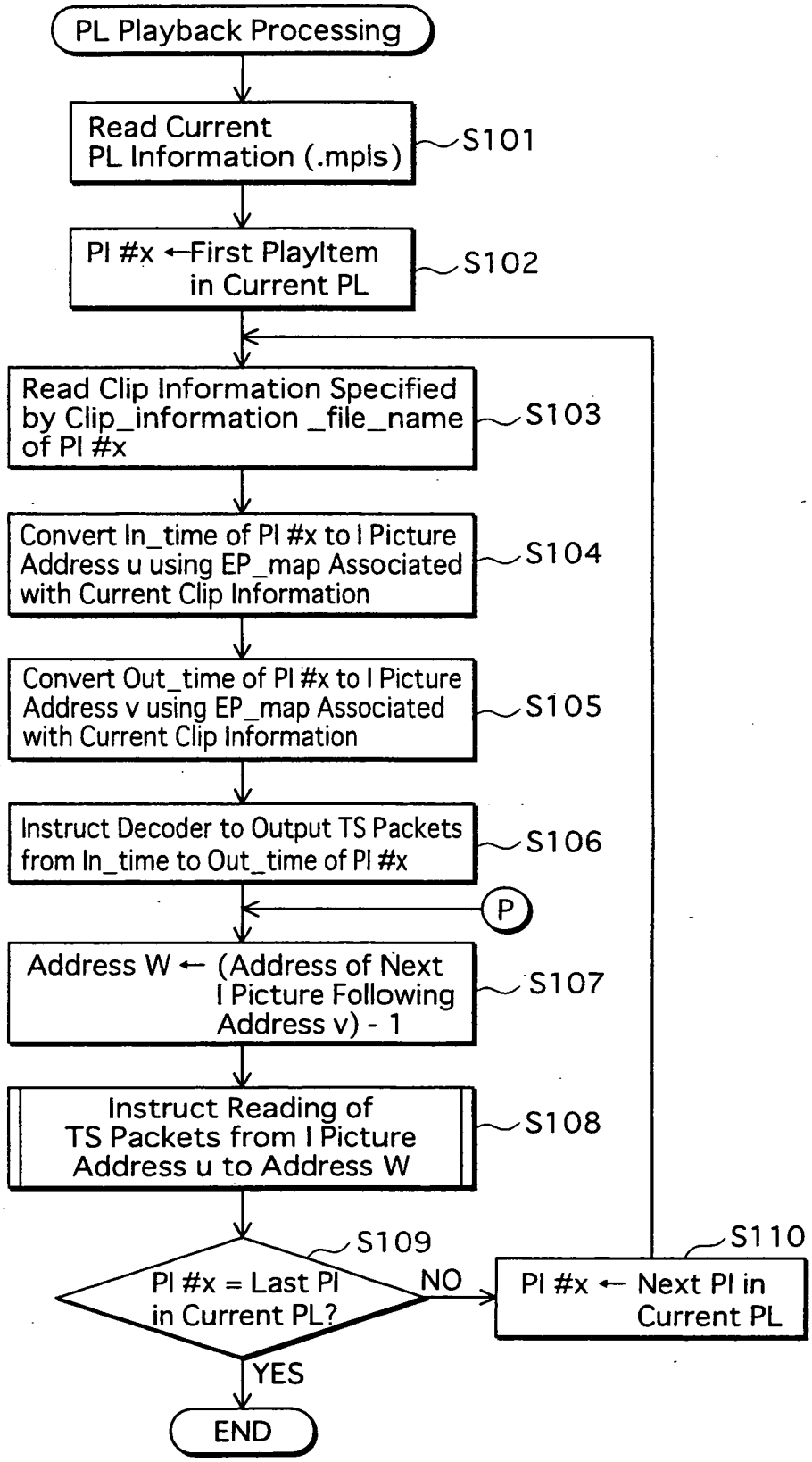
PL Playback Processing
Read Current PL Information (.mpls)
S101
PI #x ←First PlayItem in Current PL
S102
Read Clip Information Specified by Clip_information _file_name of PI #x
S103
Convert In_time of PI #x to I Picture Address u using EP_map Associated with Current Clip Information
S104
Convert Out_time of PI #x to I Picture Address v using EP_map Associated with Current Clip Information
S105
Instruct Decoder to Output TS Packets from In_time to Out_time of PI #x
S106
P
Address W ← (Address of Next I Picture Following Address v) - 1
S107
Instruct Reading of TS Packets from I Picture Address u to Address W
S108
S109
PI #x = Last PI in Current PL?
NO
S110
PI #x ← Next PI in Current PL
YES
END

FIG.24

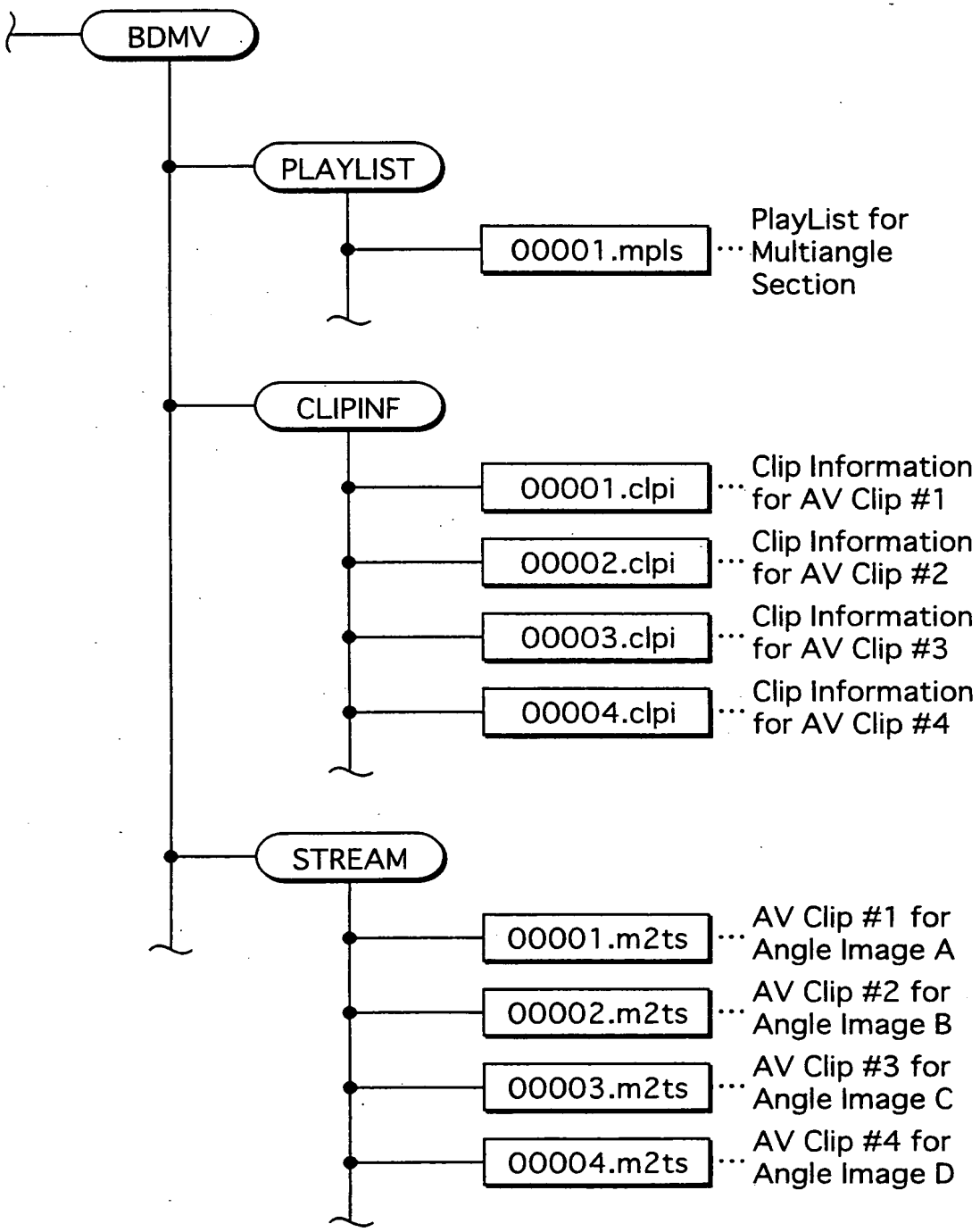
BDMV
PLAYLIST
00001.mpls
PlayList for Multiangle Section
CLIPINF
00001.clpi
Clip Information for AV Clip #1
00002.clpi
Clip Information for AV Clip #2
00003.clpi
Clip Information for AV Clip #3
00004.clpi
Clip Information for AV Clip #4
STREAM
00001.m2ts
AV Clip #1 for Angle Image A
00002.m2ts
AV Clip #2 for Angle Image B
00003.m2ts
AV Clip #3 for Angle Image C
00004.m2ts
AV Clip #4 for Angle Image D

FIG.25

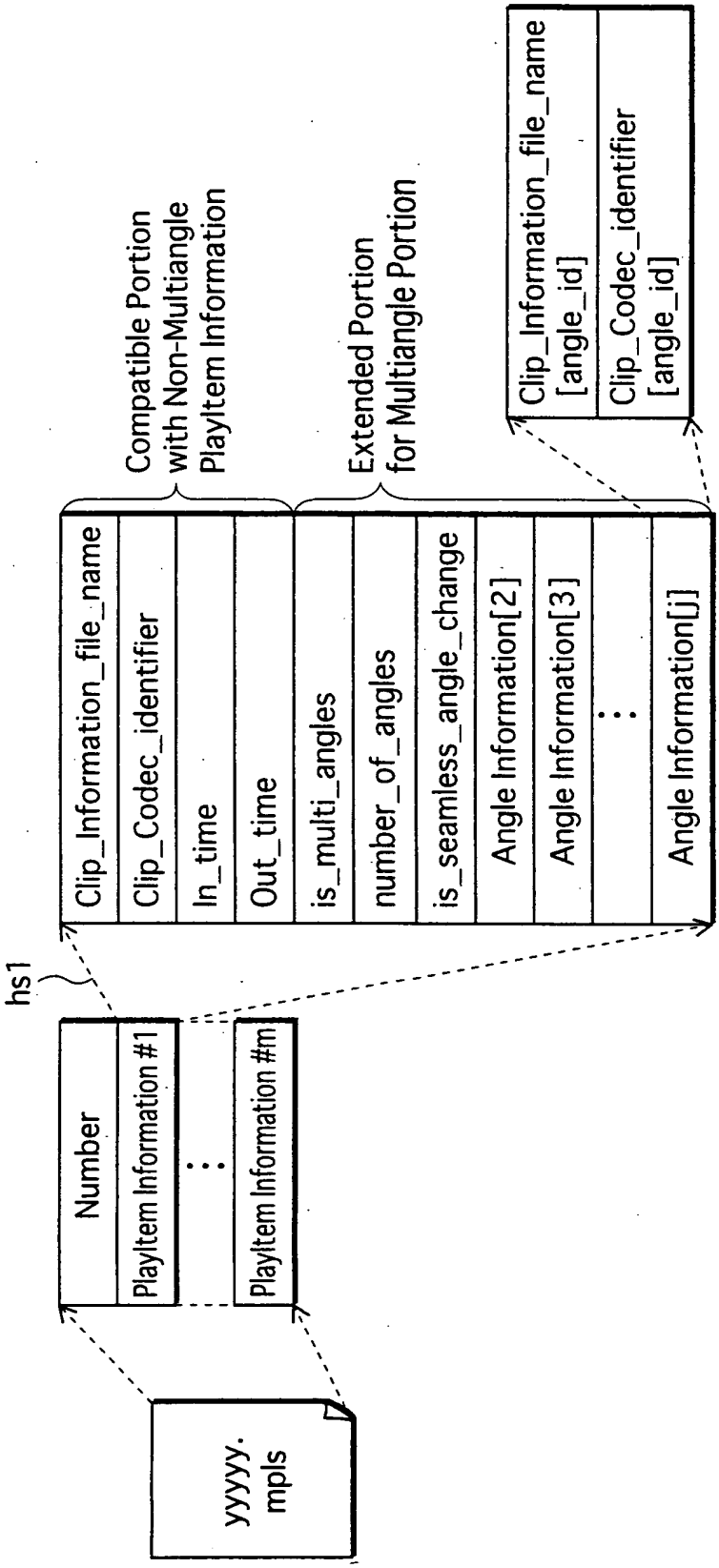
yyyyy.
mpls
Number
PlayItem Information #1
PlayItem Information #m
hs1
Clip_Information_file_name
Clip_Codec_identifier
In_time
Out_time
is_multi_angles
number_of_angles
is_seamless_angle_change
Angle Information[2]
Angle Information[3]
Angle Information[j]
Compatible Portion
with Non-Multiangle
PlayItem Information
Extended Portion
for Multiangle Portion
Clip_Information_file_name
[angle_id]
Clip_Codec_identifier
[angle_id]

FIG.26A

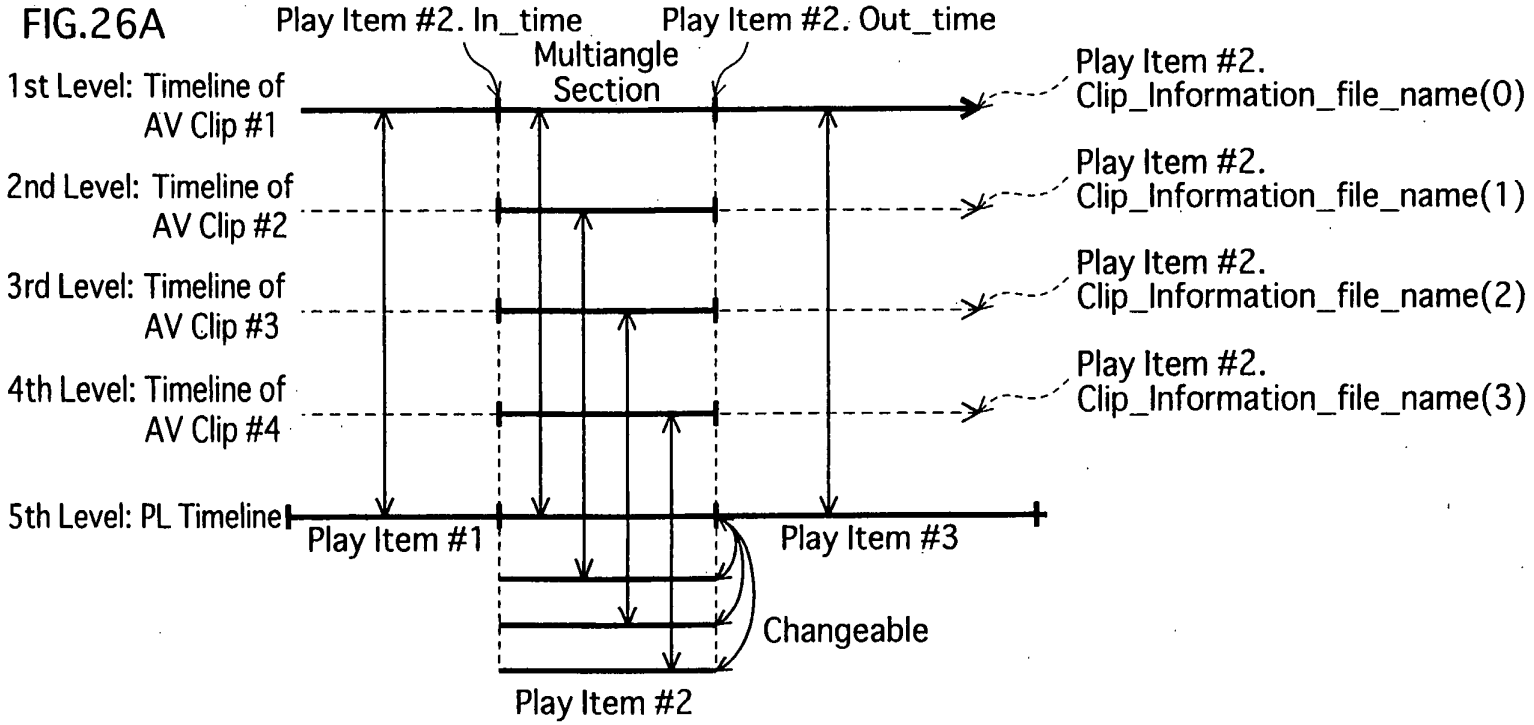

FIG.26B

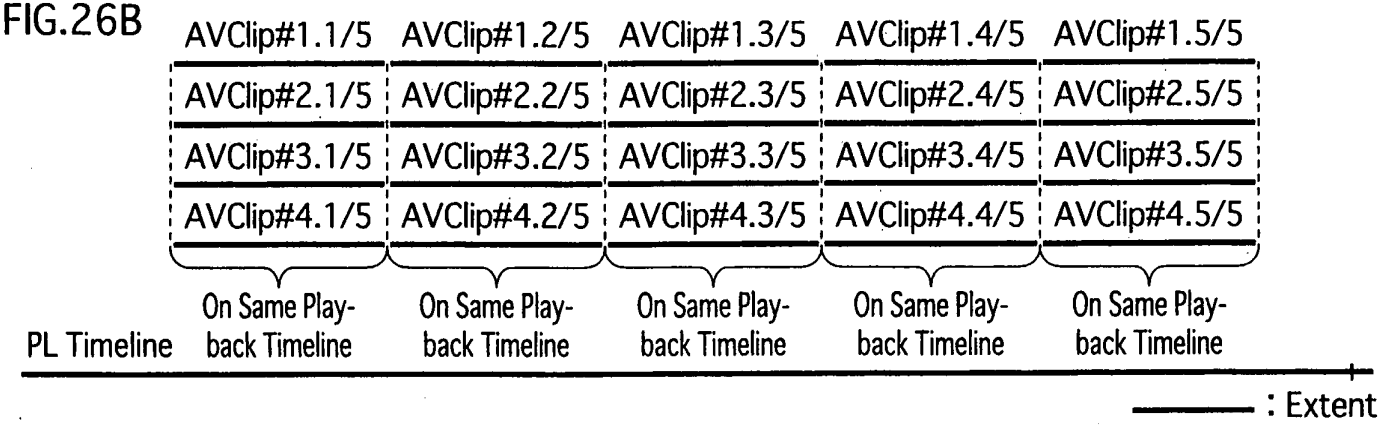

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FIG.27A

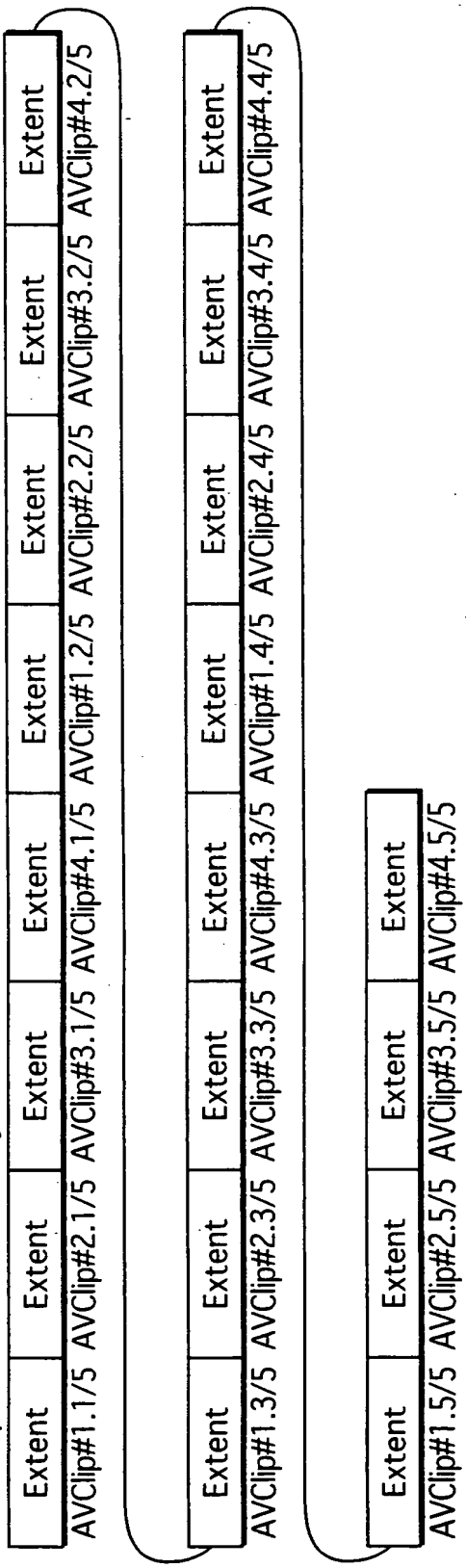


FIG.27B

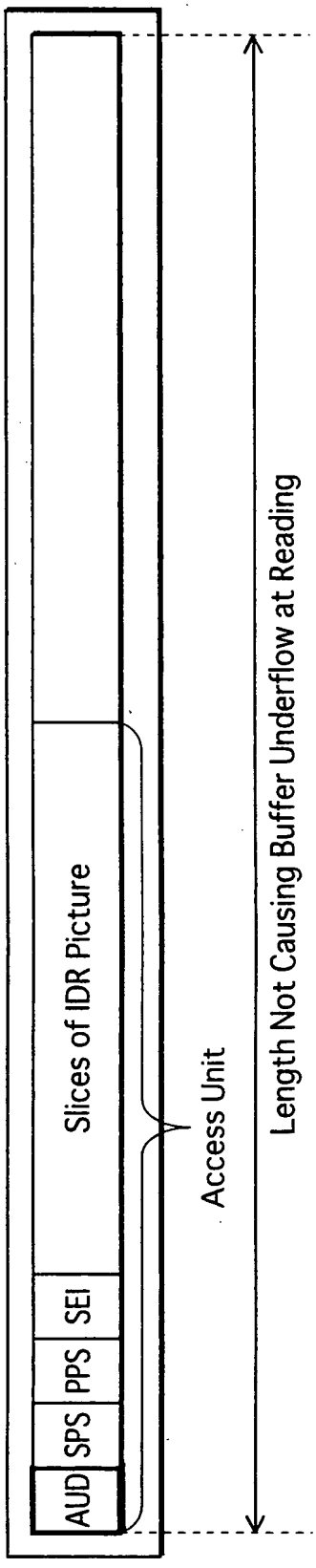


FIG.28

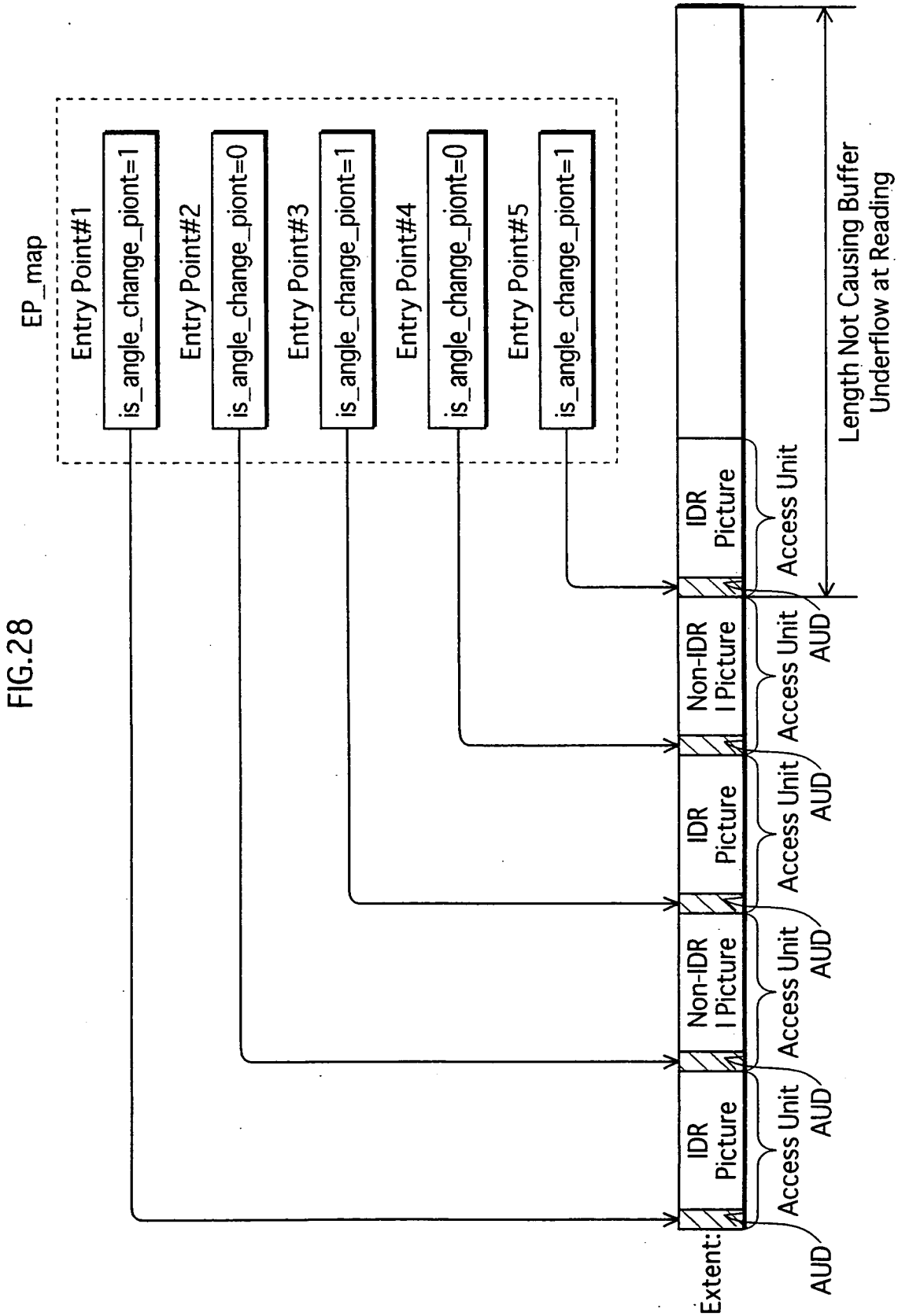
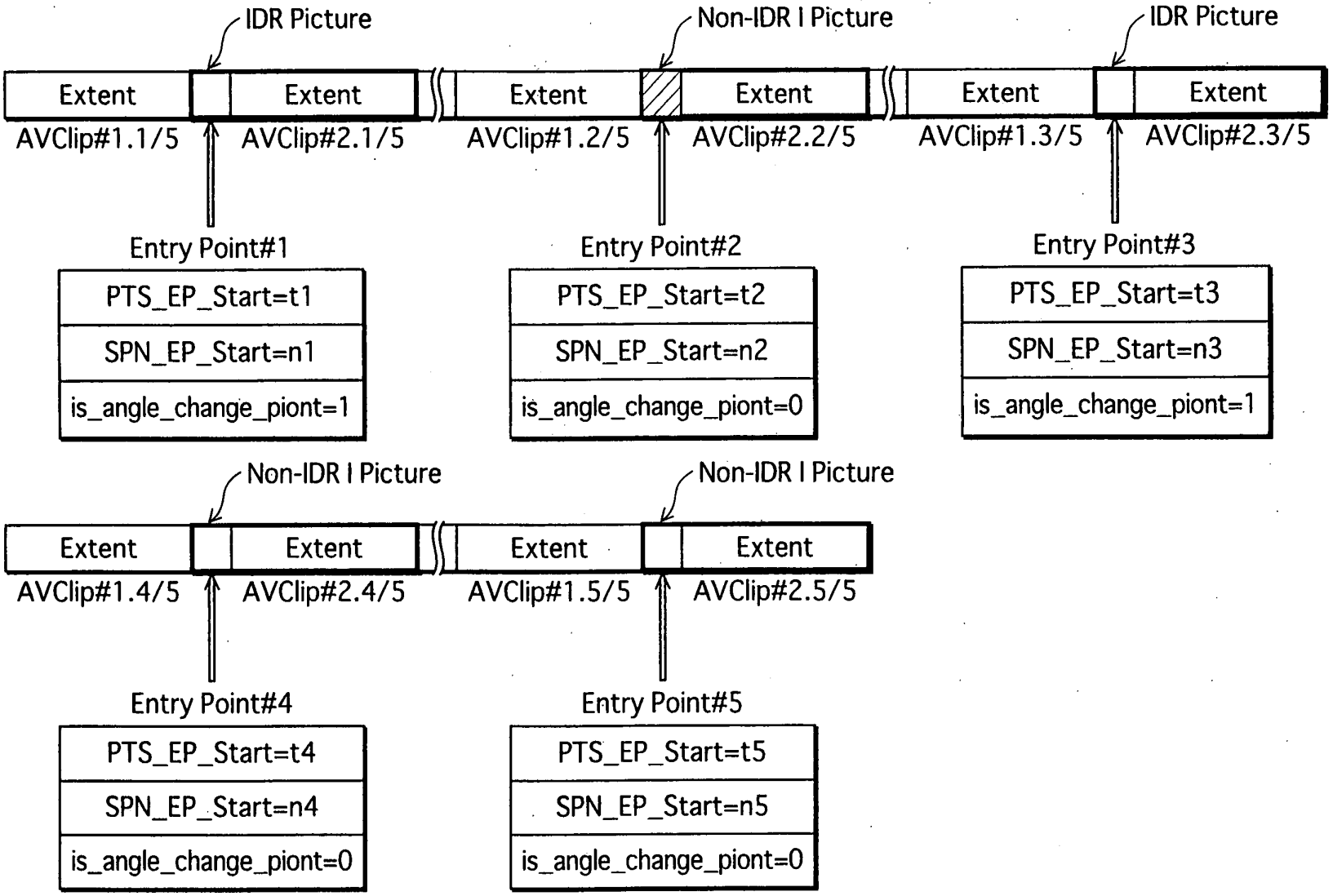

EP_map
Entry Point#1
is_angle_change_piont=1
Entry Point#2
is_angle_change_piont=0
Entry Point#3
is_angle_change_piont=1
Entry Point#4
is_angle_change_piont=0
Entry Point#5
is_angle_change_piont=1
Extent:
IDR Picture
Access Unit
AUD
Non-IDR I Picture
Access Unit
AUD
IDR Picture
Access Unit
AUD
Non-IDR I Picture
Access Unit
AUD
IDR Picture
Access Unit
AUD
Length Not Causing Buffer Underflow at Reading

FIG.29



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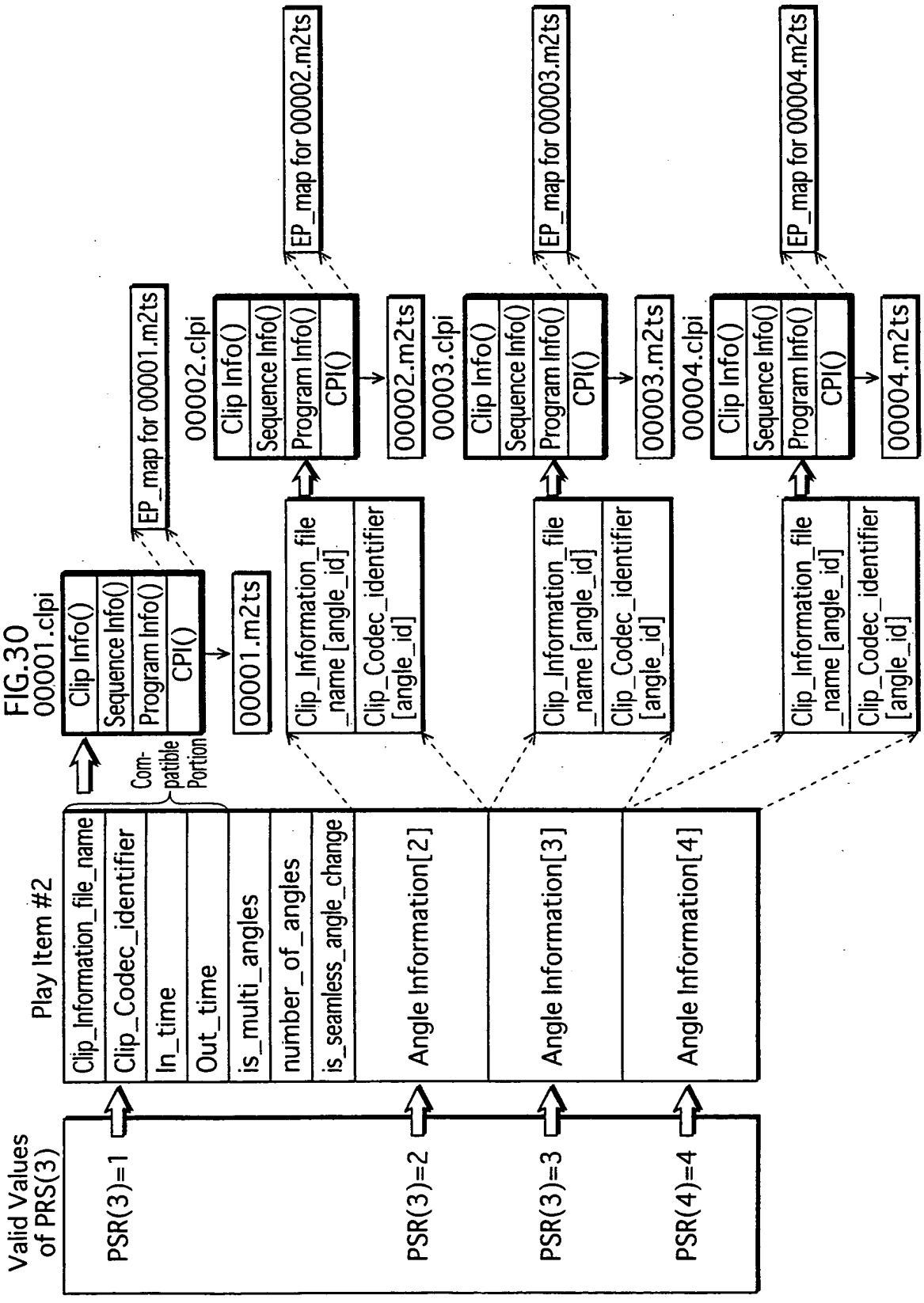

Valid Values of PRS(3)
PSR(3)=1
PSR(3)=2
PSR(3)=3
PSR(4)=4
Play Item #2
Clip_Information_file_name
Clip_Codec_identifier
In_time
Out_time
is_multi_angles
number_of_angles
is_seamless_angle_change
Angle Information[2]
Angle Information[3]
Angle Information[4]
Com-patible Portion
00001.clpi
Clip Info()
Sequence Info()
Program Info()
CPI()
EP_map for 00001.m2ts
00001.m2ts
00002.clpi
Clip_Information_file_name [angle_id]
Clip_Codec_identifier [angle_id]
EP_map for 00002.m2ts
00002.m2ts
00003.clpi
EP_map for 00003.m2ts
00003.m2ts
00004.clpi
EP_map for 00004.m2ts
00004.m2ts

FIG.30

FIG.31

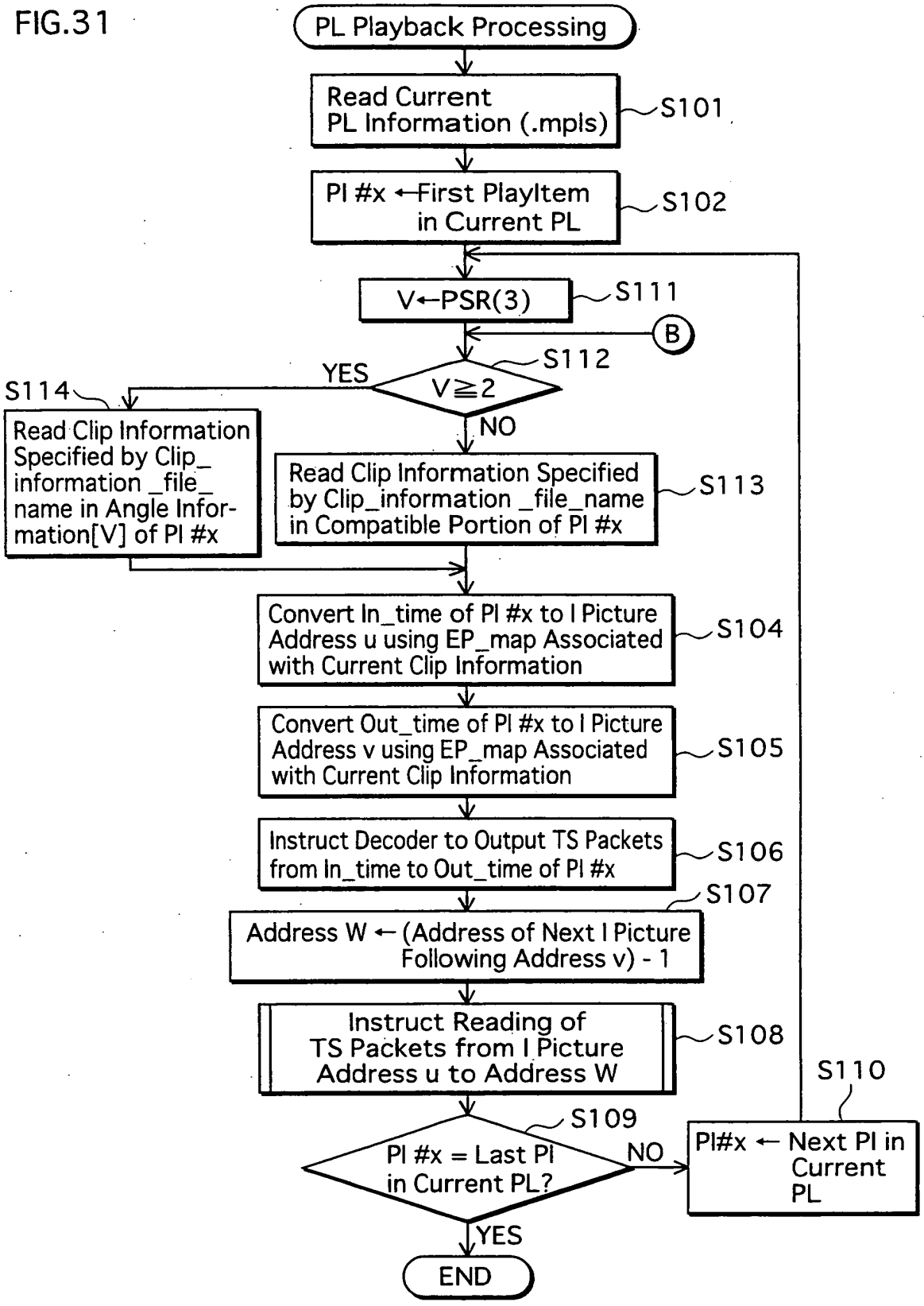

PL Playback Processing
Read Current PL Information (.mpls)
S101
PI #x ←First PlayItem in Current PL
S102
V←PSR(3)
S111
B
S112
YES
V≧2
S114
NO
Read Clip Information Specified by Clip_ information _file_ name in Angle Information[V] of PI #x
Read Clip Information Specified by Clip_information _file_name in Compatible Portion of PI #x
S113
Convert In_time of PI #x to I Picture Address u using EP_map Associated with Current Clip Information
S104
Convert Out_time of PI #x to I Picture Address v using EP_map Associated with Current Clip Information
S105
Instruct Decoder to Output TS Packets from In_time to Out_time of PI #x
S106
S107
Address W ← (Address of Next I Picture Following Address v) - 1
Instruct Reading of TS Packets from I Picture Address u to Address W
S108
S110
S109
PI #x = Last PI in Current PL?
NO
PI#x ← Next PI in Current PL
YES
END

FIG.32

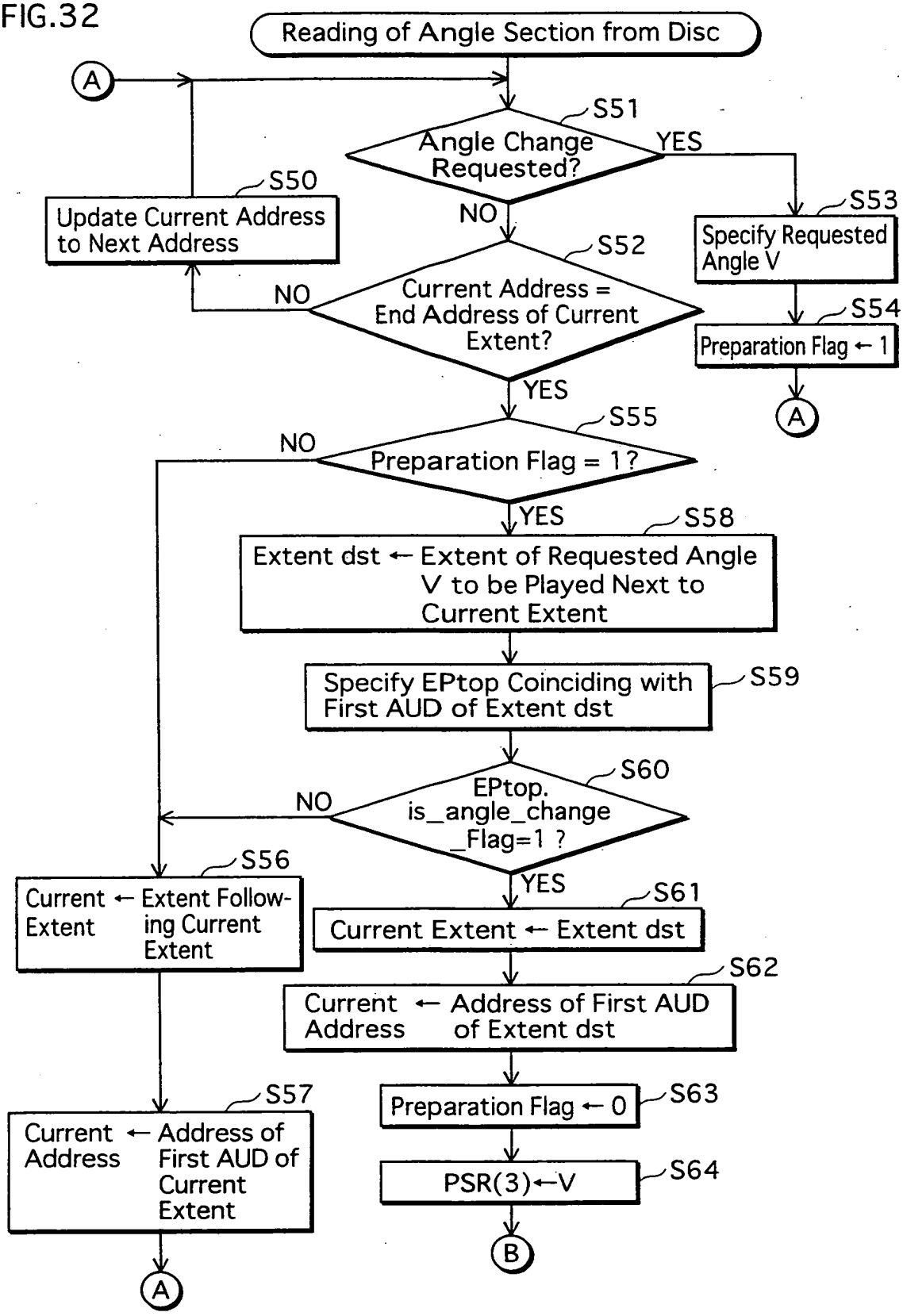

Reading of Angle Section from Disc
A
S51
Angle Change Requested?
YES
NO
S50
Update Current Address to Next Address
S52
Current Address = End Address of Current Extent?
NO
YES
S53
Specify Requested Angle V
S54
Preparation Flag ← 1
A
S55
Preparation Flag = 1?
NO
YES
S58
Extent dst ← Extent of Requested Angle V to be Played Next to Current Extent
S59
Specify EPtop Coinciding with First AUD of Extent dst
S60
EPtop. is_angle_change _Flag=1 ?
NO
YES
S56
Current Extent ← Extent Following Current Extent
S61
Current Extent ← Extent dst
S62
Current Address ← Address of First AUD of Extent dst
S57
Current Address ← Address of First AUD of Current Extent
S63
Preparation Flag ← 0
S64
PSR(3)←V
B
A

FIG.33

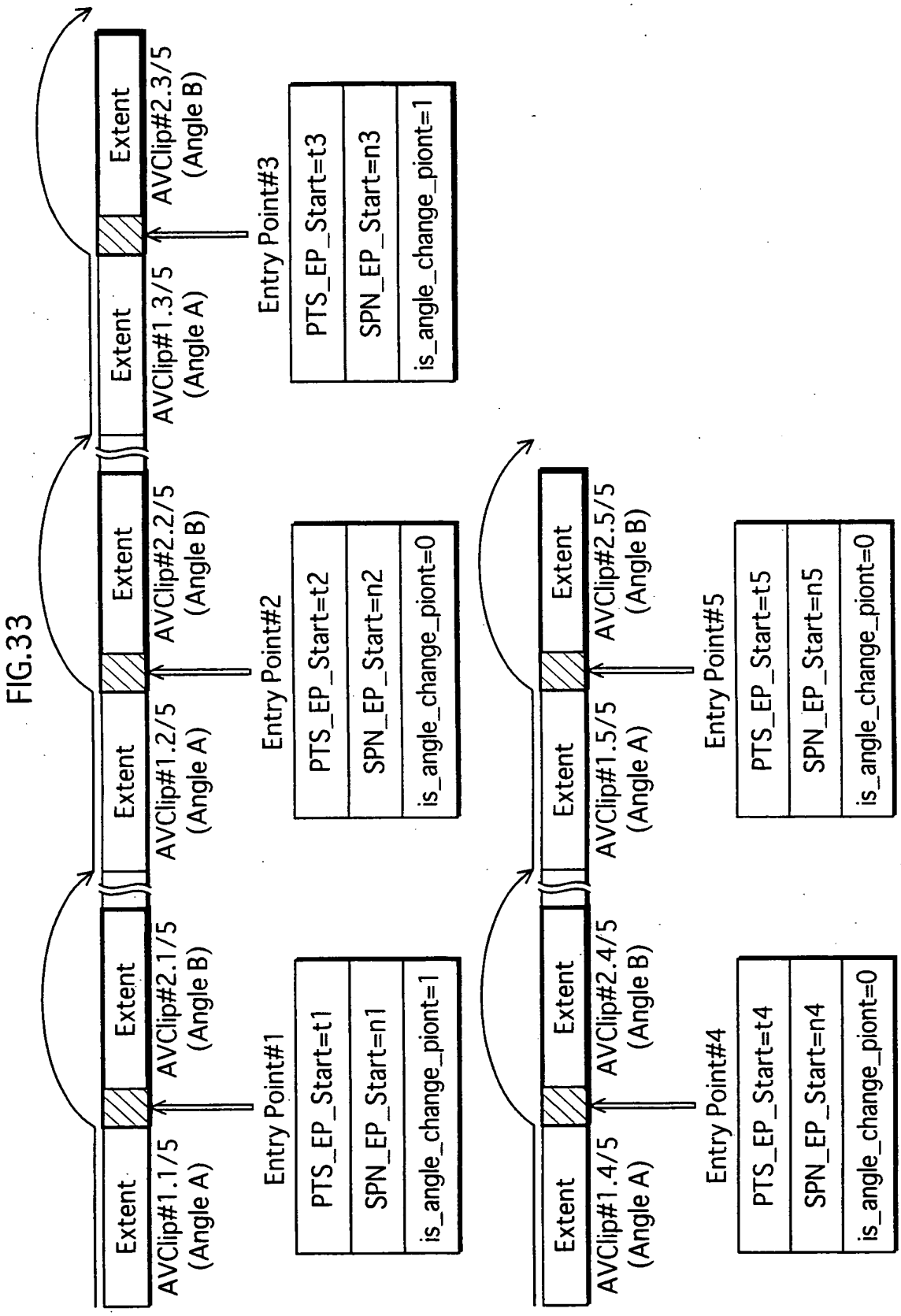

Extent
Extent
Extent
Extent
Extent
Extent
AVClip#1.1/5
(Angle A)
AVClip#2.1/5
(Angle B)
AVClip#1.2/5
(Angle A)
AVClip#2.2/5
(Angle B)
AVClip#1.3/5
(Angle A)
AVClip#2.3/5
(Angle B)
Entry Point#1
PTS_EP_Start=t1
SPN_EP_Start=n1
is_angle_change_piont=1
Entry Point#2
PTS_EP_Start=t2
SPN_EP_Start=n2
is_angle_change_piont=0
Entry Point#3
PTS_EP_Start=t3
SPN_EP_Start=n3
is_angle_change_piont=1
Extent
Extent
Extent
Extent
Extent
Extent
AVClip#1.4/5
(Angle A)
AVClip#2.4/5
(Angle B)
AVClip#1.5/5
(Angle A)
AVClip#2.5/5
(Angle B)
Entry Point#4
PTS_EP_Start=t4
SPN_EP_Start=n4
is_angle_change_piont=0
Entry Point#5
PTS_EP_Start=t5
SPN_EP_Start=n5
is_angle_change_piont=0

FIG.34

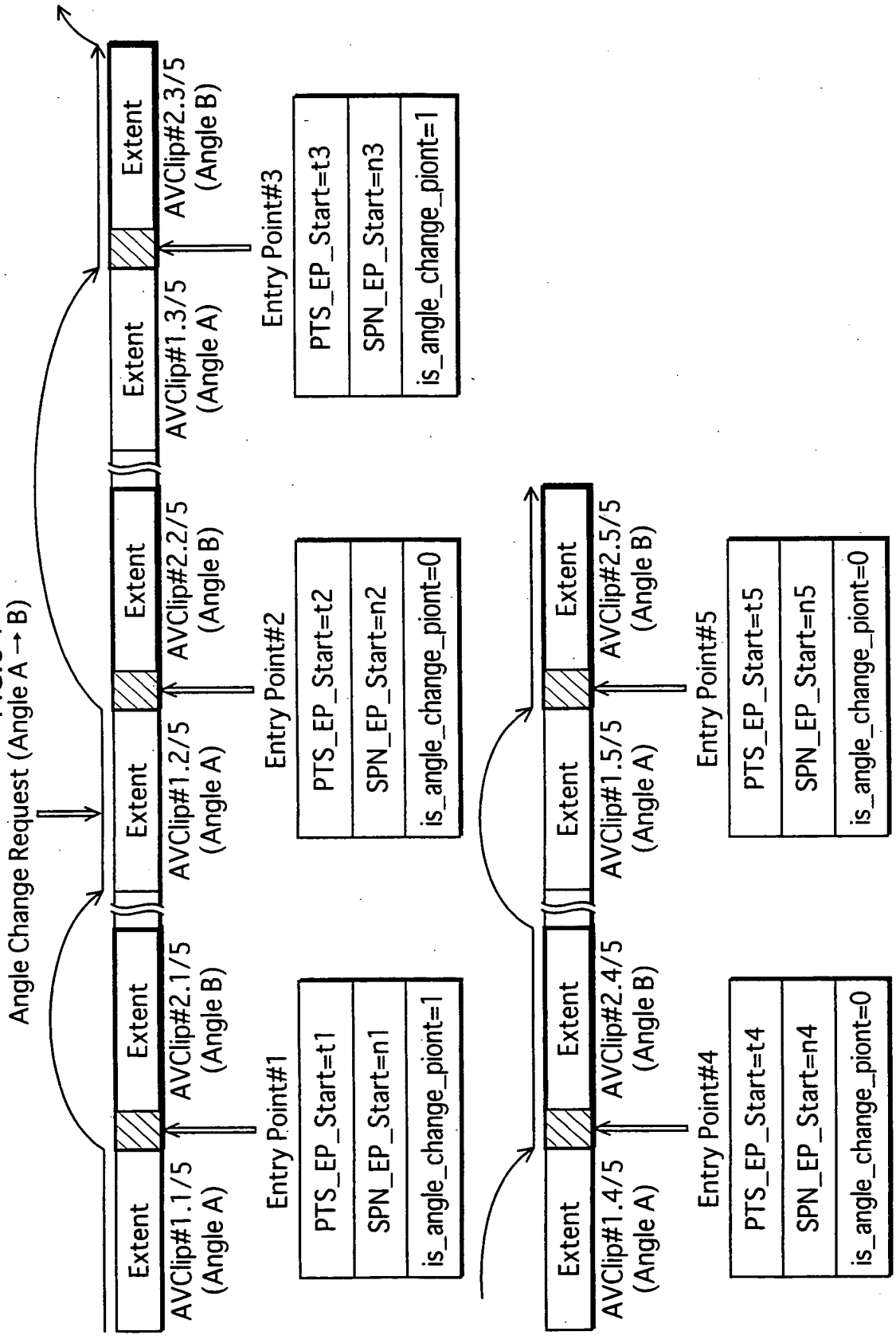

Angle Change Request (Angle A → B)
Extent
AVClip#1.1/5 (Angle A)
Extent
AVClip#2.1/5 (Angle B)
Extent
AVClip#1.2/5 (Angle A)
Extent
AVClip#2.2/5 (Angle B)
Extent
AVClip#1.3/5 (Angle A)
Extent
AVClip#2.3/5 (Angle B)
Entry Point#1
PTS_EP_Start=t1
SPN_EP_Start=n1
is_angle_change_piont=1
Entry Point#2
PTS_EP_Start=t2
SPN_EP_Start=n2
is_angle_change_piont=0
Entry Point#3
PTS_EP_Start=t3
SPN_EP_Start=n3
is_angle_change_piont=1
Extent
AVClip#1.4/5 (Angle A)
Extent
AVClip#2.4/5 (Angle B)
Extent
AVClip#1.5/5 (Angle A)
Extent
AVClip#2.5/5 (Angle B)
Entry Point#4
PTS_EP_Start=t4
SPN_EP_Start=n4
is_angle_change_piont=0
Entry Point#5
PTS_EP_Start=t5
SPN_EP_Start=n5
is_angle_change_piont=0

FIG.35

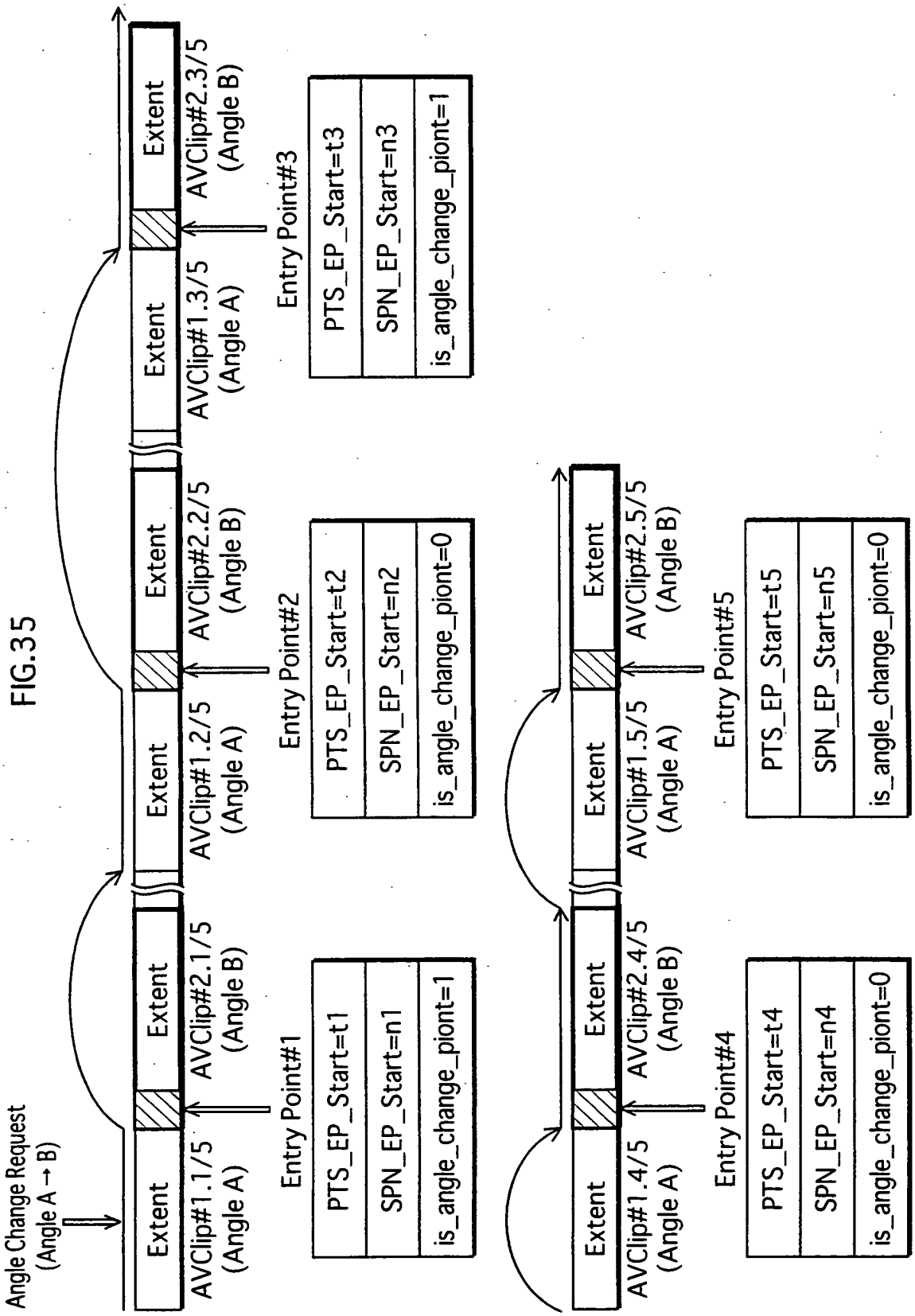

Angle Change Request
(Angle A → B)
Extent
Extent
Extent
Extent
Extent
Extent
AVClip#1.1/5
(Angle A)
AVClip#2.1/5
(Angle B)
AVClip#1.2/5
(Angle A)
AVClip#2.2/5
(Angle B)
AVClip#1.3/5
(Angle A)
AVClip#2.3/5
(Angle B)
Entry Point#1
PTS_EP_Start=t1
SPN_EP_Start=n1
is_angle_change_piont=1
Entry Point#2
PTS_EP_Start=t2
SPN_EP_Start=n2
is_angle_change_piont=0
Entry Point#3
PTS_EP_Start=t3
SPN_EP_Start=n3
is_angle_change_piont=1
Extent
Extent
Extent
Extent
AVClip#1.4/5
(Angle A)
AVClip#2.4/5
(Angle B)
AVClip#1.5/5
(Angle A)
AVClip#2.5/5
(Angle B)
Entry Point#4
PTS_EP_Start=t4
SPN_EP_Start=n4
is_angle_change_piont=0
Entry Point#5
PTS_EP_Start=t5
SPN_EP_Start=n5
is_angle_change_piont=0

FIG.36

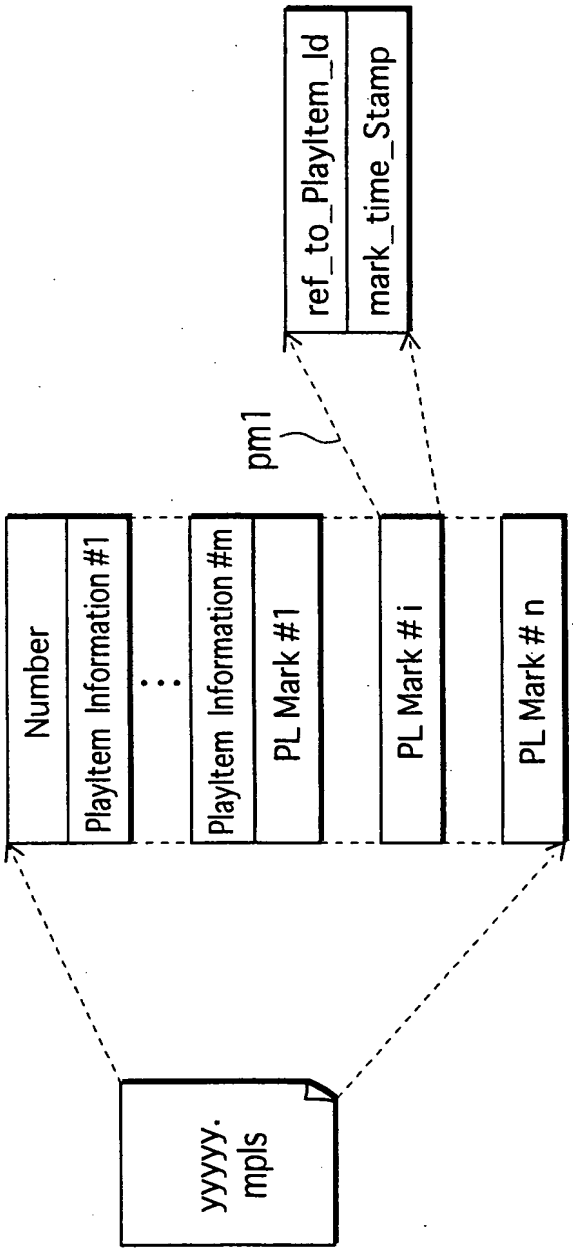

ref_to_PlayItem_Id
mark_time_Stamp
pm1
Number
PlayItem Information #1
PlayItem Information #m
PL Mark #1
PL Mark # i
PL Mark # n
yyyyy.
mpls

FIG.37

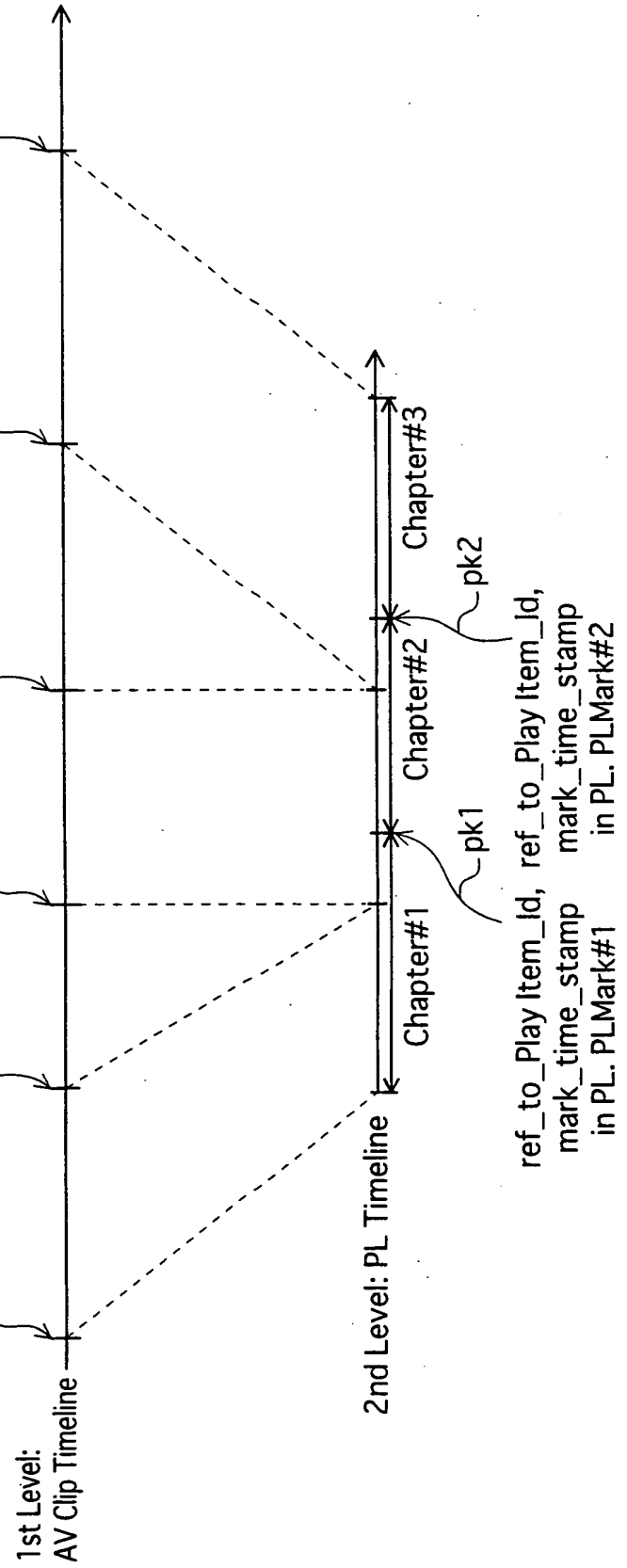

Play Item #3.
Out_time
Play Item #3.In_time
Play Item #2.Out_time
Play Item #2.In_time
Play Item #1.Out_time
Play Item #1.In_time
1st Level:
AV Clip Timeline
2nd Level: PL Timeline
Chapter#1
Chapter#2
Chapter#3
pk1
pk2
ref_to_Play Item_Id,
mark_time_stamp
in PL. PLMark#1
ref_to_Play Item_Id,
mark_time_stamp
in PL. PLMark#2

FIG.38

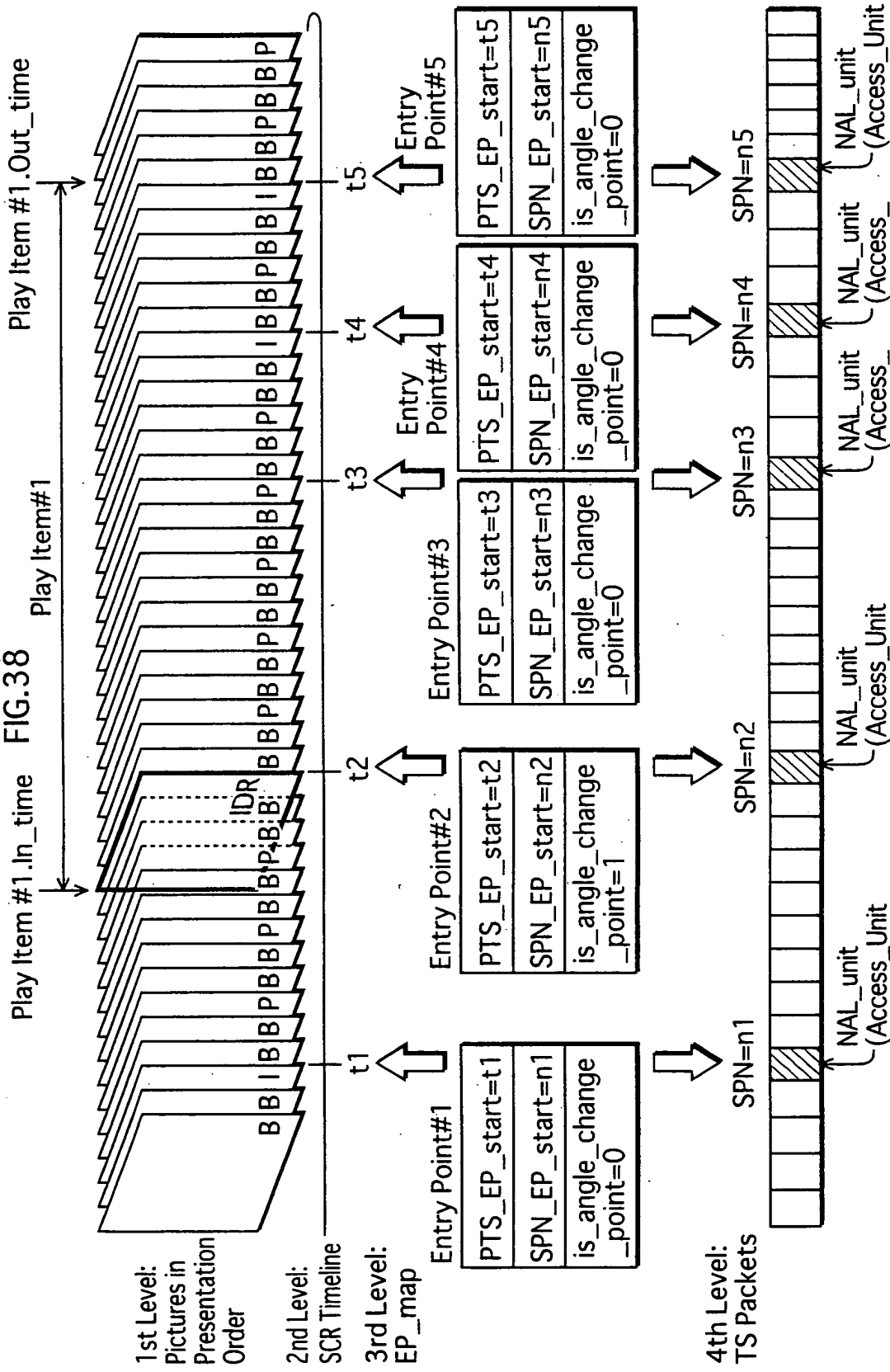
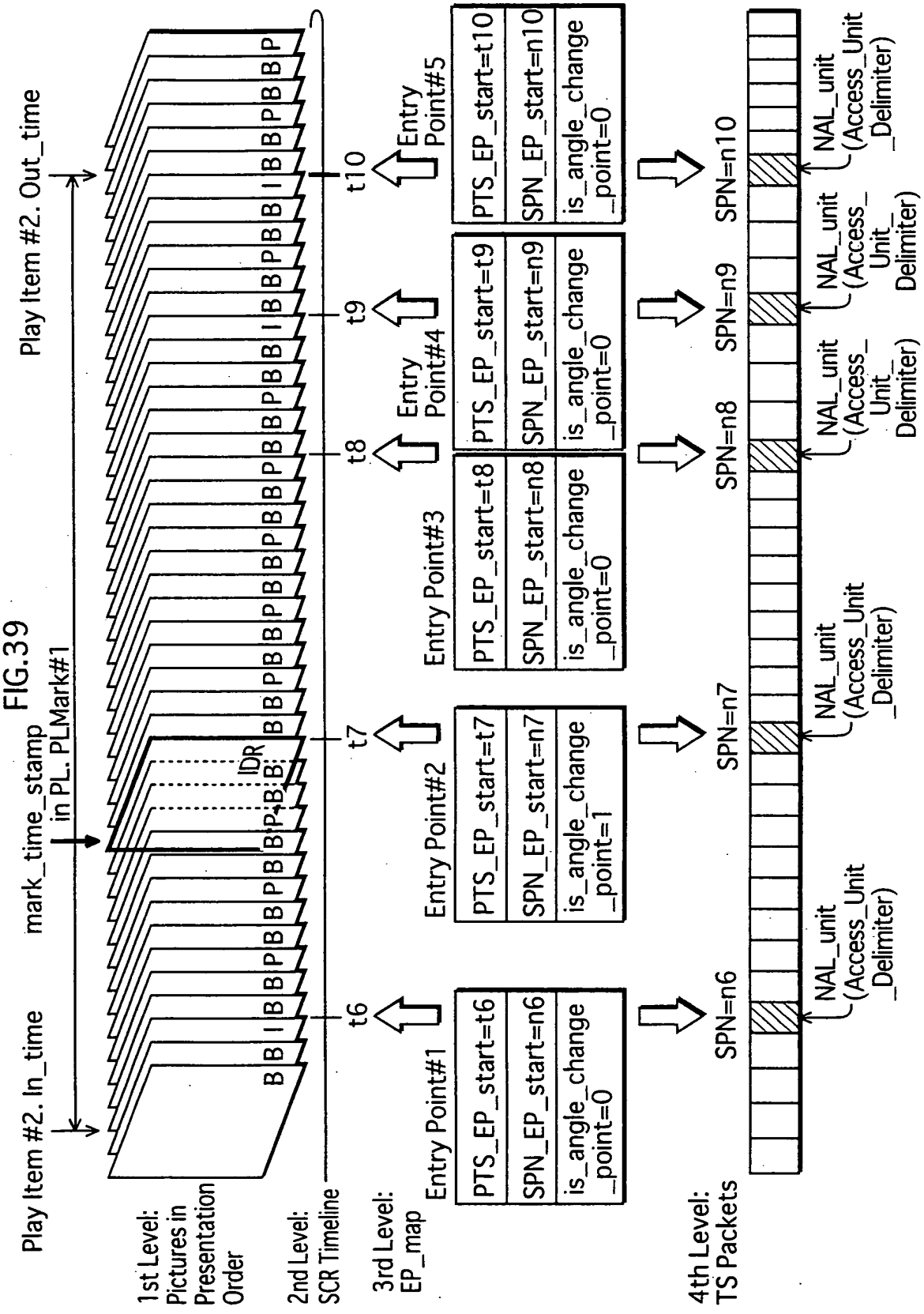

Play Item #1.In_time
Play Item#1
Play Item #1.Out_time
1st Level: Pictures in Presentation Order
2nd Level: SCR Timeline
3rd Level: EP_map
4th Level: TS Packets
IDR
B B I B B P B B P B B P B B P B B P B B P B B P B B I B B P B B I B B P B P
t1
t2
t3
t4
t5
Entry Point#1
Entry Point#2
Entry Point#3
Entry Point#4
Entry Point#5
PTS_EP_start=t1
SPN_EP_start=n1
is_angle_change _point=0
PTS_EP_start=t2
SPN_EP_start=n2
is_angle_change _point=1
PTS_EP_start=t3
SPN_EP_start=n3
is_angle_change _point=0
PTS_EP_start=t4
SPN_EP_start=n4
is_angle_change _point=0
PTS_EP_start=t5
SPN_EP_start=n5
is_angle_change _point=0
SPN=n1
SPN=n2
SPN=n3
SPN=n4
SPN=n5
NAL_unit (Access_Unit _Delimiter)
NAL_unit (Access_ Unit_ Delimiter)
NAL_unit (Access_Unit _Delimiter)
NAL_unit (Access_ Unit_ Delimiter)
NAL_unit (Access_Unit _Delimiter)

FIG.39


Play Item #2. In_time
Play Item #2. Out_time
mark_time_stamp in PL. PLMark#1
1st Level: Pictures in Presentation Order
2nd Level: SCR Timeline
3rd Level: EP_map
4th Level: TS Packets
IDR
B B I B B P B B P B B P B B P B B P B B P B B P B B I B B P B B I B B P B P
t6
t7
t8
t9
t10
Entry Point#1
Entry Point#2
Entry Point#3
Entry Point#4
Entry Point#5
PTS_EP_start=t6
SPN_EP_start=n6
is_angle_change_point=0
PTS_EP_start=t7
SPN_EP_start=n7
is_angle_change_point=1
PTS_EP_start=t8
SPN_EP_start=n8
is_angle_change_point=0
PTS_EP_start=t9
SPN_EP_start=n9
is_angle_change_point=0
PTS_EP_start=t10
SPN_EP_start=n10
is_angle_change_point=0
SPN=n6
SPN=n7
SPN=n8
SPN=n9
SPN=n10
NAL_unit (Access_Unit Delimiter)
NAL_unit (Access_ Unit_ Delimiter)

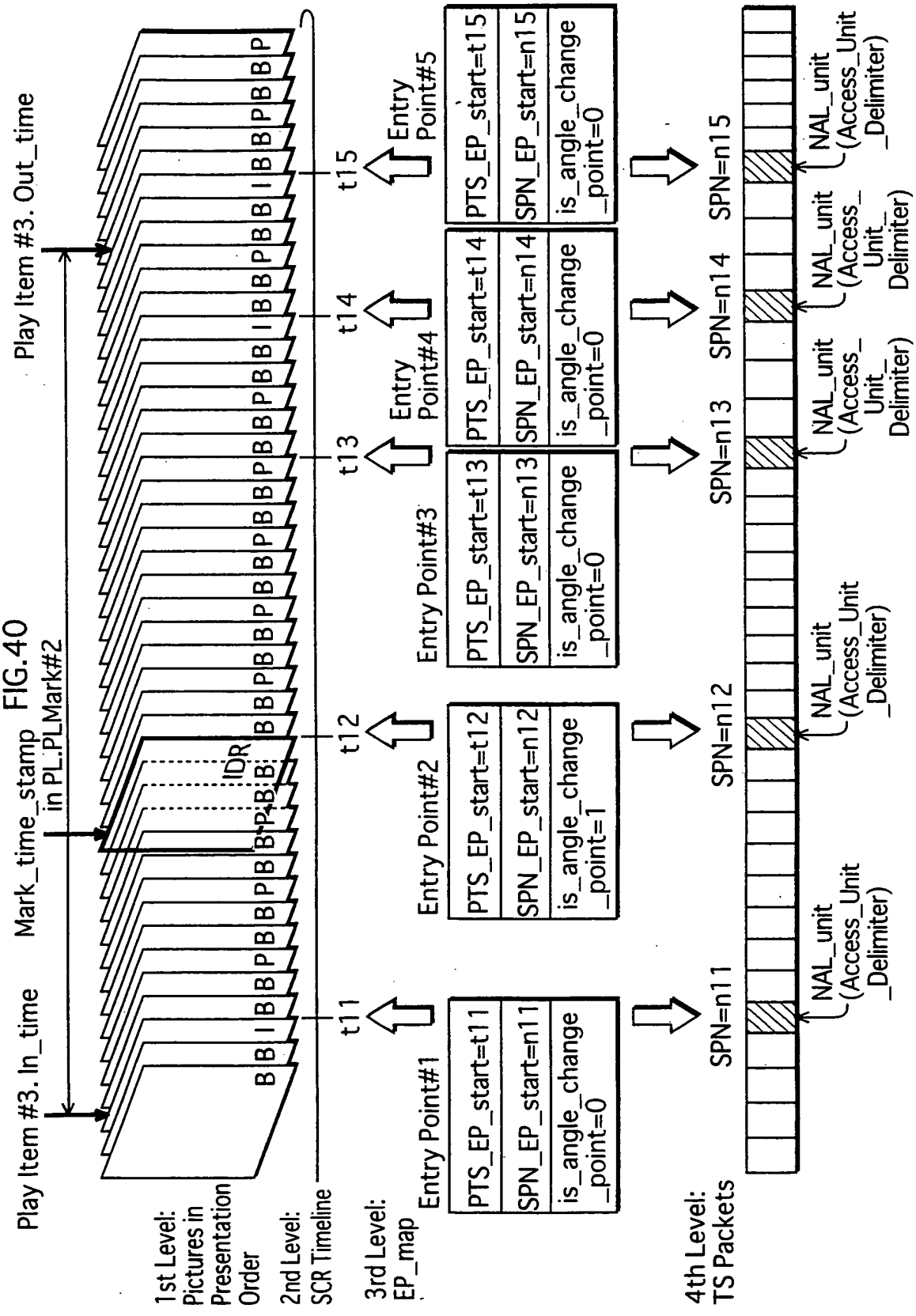

Play Item #3. In_time
Mark_time_stamp in PL.PLMark#2
Play Item #3. Out_time
1st Level: Pictures in Presentation Order
2nd Level: SCR Timeline
3rd Level: EP_map
4th Level: TS Packets
Entry Point#1
Entry Point#2
Entry Point#3
Entry Point#4
Entry Point#5
t11
t12
t13
t14
t15
PTS_EP_start=t11
SPN_EP_start=n11
is_angle_change _point=0
PTS_EP_start=t12
SPN_EP_start=n12
is_angle_change _point=1
PTS_EP_start=t13
SPN_EP_start=n13
is_angle_change _point=0
PTS_EP_start=t14
SPN_EP_start=n14
is_angle_change _point=0
PTS_EP_start=t15
SPN_EP_start=n15
is_angle_change _point=0
SPN=n11
SPN=n12
SPN=n13
SPN=n14
SPN=n15
NAL_unit (Access_Unit _Delimiter)
NAL_unit (Access_ Unit_ Delimiter)
NAL_unit (Access_Unit _Delimiter)
NAL_unit (Access_ Unit_ Delimiter)
NAL_unit (Access_Unit _Delimiter)

FIG.40

FIG.41

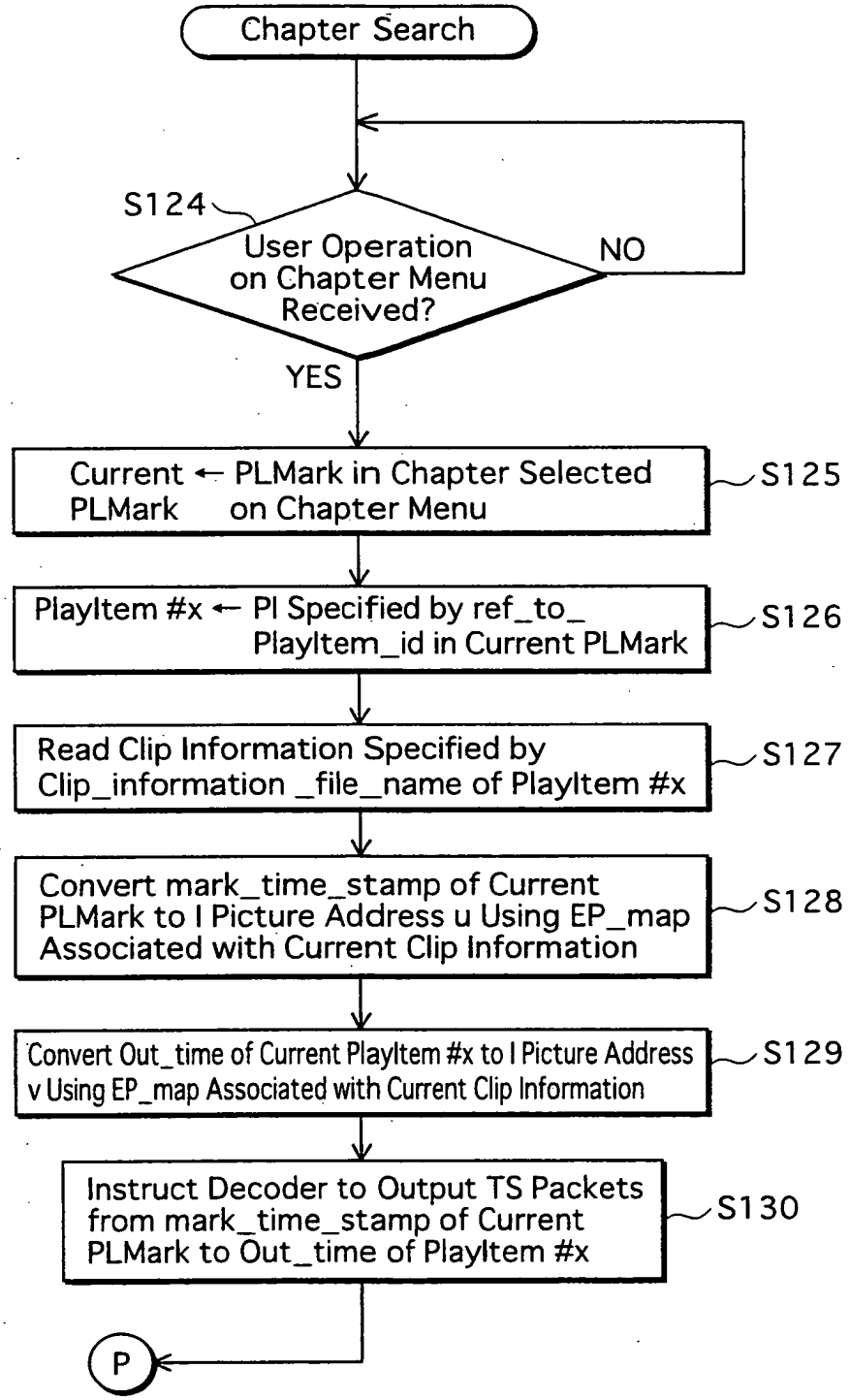
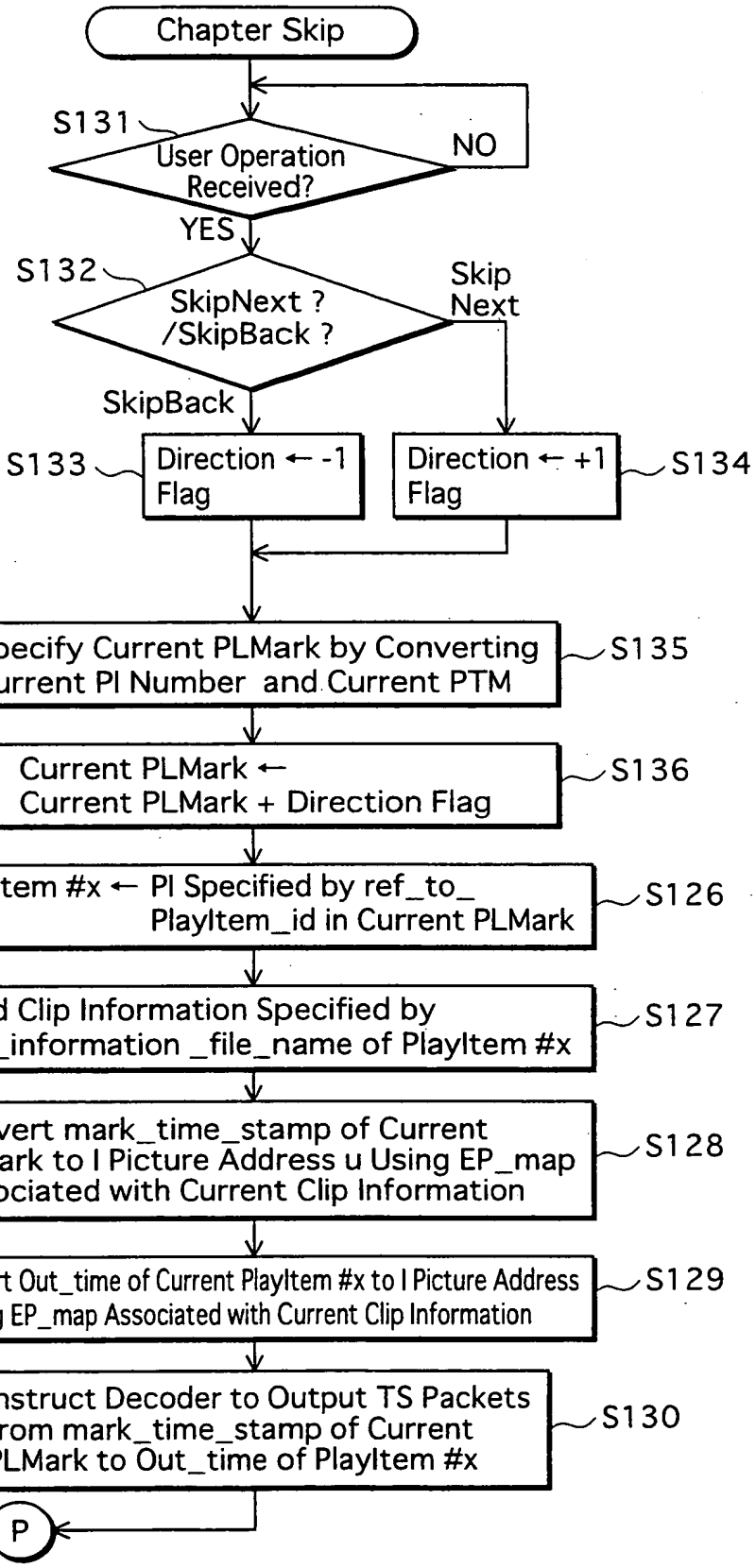

Chapter Search
S124
User Operation on Chapter Menu Received?
NO
YES
Current PLMark ← PLMark in Chapter Selected on Chapter Menu
S125
PlayItem #x ← PI Specified by ref_to_PlayItem_id in Current PLMark
S126
Read Clip Information Specified by Clip_information _file_name of PlayItem #x
S127
Convert mark_time_stamp of Current PLMark to I Picture Address u Using EP_map Associated with Current Clip Information
S128
Convert Out_time of Current PlayItem #x to I Picture Address v Using EP_map Associated with Current Clip Information
S129
Instruct Decoder to Output TS Packets from mark_time_stamp of Current PLMark to Out_time of PlayItem #x
S130
P

FIG.42


Chapter Skip
S131
User Operation Received?
NO
YES
S132
SkipNext ? /SkipBack ?
Skip Next
SkipBack
S133
Direction ← -1 Flag
Direction ← +1 Flag
S134
Specify Current PLMark by Converting Current PI Number and Current PTM
S135
Current PLMark ← Current PLMark + Direction Flag
S136
PlayItem #x ← PI Specified by ref_to_ PlayItem_id in Current PLMark
S126
Read Clip Information Specified by Clip_information _file_name of PlayItem #x
S127
Convert mark_time_stamp of Current PLMark to I Picture Address u Using EP_map Associated with Current Clip Information
S128
Convert Out_time of Current PlayItem #x to I Picture Address v Using EP_map Associated with Current Clip Information
S129
Instruct Decoder to Output TS Packets from mark_time_stamp of Current PLMark to Out_time of PlayItem #x
S130
P